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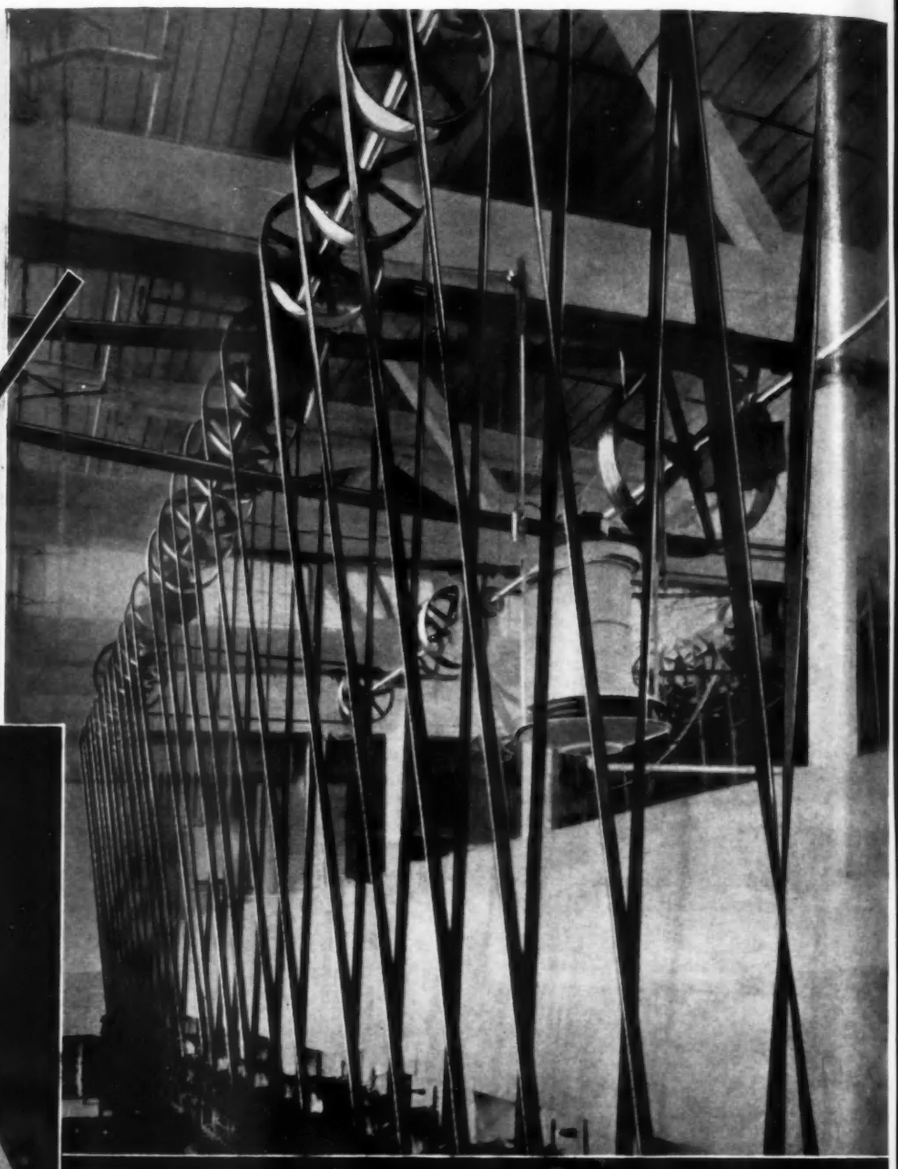

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GRAPHICAL METHOD OF DESIGNING RIGHT-ANGLE HELICAL GEARING.

By PAUL GRODZINSKI.

FOR determining the helical angle of right-angle helical gearing, an elaborate diagram has been produced recently,* as a mathematical solution was inconvenient, leading to an equation of the fourth power. The writer, who referred to the mathematical solution in a letter published in ENGINEERING of March 21, 1941, on page 234, now proposes to give another graphical solution, making use of a single standard curve, which is easily drawn and is the same for all kinds of right-angle helical gearing. This curve has to be intersected by a straight line, the axis sections of which must correspond to the given data for the gearing. The intersection point gives immediately the suitable helical angle and the correct values may be found by graphical interpolation or extrapolation.

The diagram, Fig. 1, is based on the fundamental relation

$$R \sec \alpha + \operatorname{cosec} \alpha = \frac{2 \cdot C \cdot P_n}{n}, \quad . \quad (1)$$

in which α is the helical angle of both gears, $R = N/n$ is the ratio of the numbers of teeth in the two wheels (usually $n < N$), P_n is the normal pitch in inches, and C is the centre distance in inches.

This equation can be transformed into the equation for a straight line :—

$$\frac{x}{a} + \frac{y}{b} = 1 \quad . \quad . \quad . \quad (2)$$

with the co-ordinate sections a and b, if we introduce

$$\sec \alpha = x, \quad \operatorname{cosec} \alpha = y,$$

$$a = \frac{2 \cdot C \cdot P_n}{N} \text{ and } b = \frac{2 \cdot C \cdot P_n}{n}.$$

Therefore, if C, P_n, N and n are given, the straight line is easily drawn in a system of rectangular co-ordinates. But only the points on this straight line for which the further relation between sec α and cosec α, *i.e.*,

$$\frac{1}{\sec^2 \alpha} + \frac{1}{\operatorname{cosec}^2 \alpha} = 1$$

is maintained, satisfy the basic equation (1). This relation may be written in the form

$$\frac{1}{x^2} + \frac{1}{y^2} = 1.$$

This represents a hyperbolic curve, symmetrical about a straight line at 45 deg. For a given value of x, the value of y may be found from the transformation

$$y = \frac{x}{\sqrt{x^2 - 1}}.$$

From this, it will be seen that both x and y must be well above unity in the positive sector with which we are concerned in this case; the lines $x = 1$ and $y = 1$ form asymptotes.

The intersection of this standard curve by the straight line, representing the particular gear, usually gives two intersection points, *i.e.*, points which satisfy both equations and therefore give suitable helical angles. If, however, the straight line becomes tangent to the curve, only one angle results. Fig. 2 shows diagrammatically this special relation, which yields the minimum centre distance. By differentiation of the equation, we obtain for the tangent angle,

$$\tan \delta = \frac{d\,y}{d\,x} = \left(\frac{y}{x}\right)^3 = \frac{b}{a} = \frac{N}{n} = R.$$

Further,

$$\frac{x}{y} = \frac{\sec \alpha}{\operatorname{cosec} \alpha} = \frac{\sin \alpha}{\cos \alpha} = \tan \alpha = \sqrt[3]{\frac{n}{N}} = \sqrt[3]{\frac{1}{R}},$$

a relation which may also be derived from the main equation. (See page 234, March 21, 1941.)

An example will demonstrate the application of the diagram. A right-angle helical gear is required with $P_n = 10$, $N = 38$, $n = 54$ for a centre distance $C = 7{\cdot}4$ in. From this, $R = \frac{N}{n} = 0{\cdot}7037$, $\frac{2 \cdot C \cdot P_n}{n} = 2{\cdot}900$, $a = 4{\cdot}122$, and $b = 2{\cdot}9$. This line intersects the hyperbolic curve in $x_1 = 2{\cdot}59$ and $y_1 = 1{\cdot}08$, as well as in $x_2 = 1{\cdot}14$ and $y_2 = 2{\cdot}1$. Owing to unavoidable errors in drawing and reading the diagram, these values are not exact, but by using the main equation and a table of trigonometric functions, in particular by graphical interpolation and extrapolation, the values may be found almost exactly; for instance, in the case in which $x_1 = \sec \alpha$, we obtain for 2·59, $\alpha = 67$ deg. 17 min., and for $y_1 = \operatorname{cosec} \alpha$ for 1·08, $\alpha_2 = 67$ deg. 48 min., values which are not in absolute conformity. As the exact result is unknown, we use two correlated values of sec α and cosec α; for instance, for 67 deg. 20 min. and 67 deg. 17 min. By introducing the corresponding values in the main equation (1), for this particular case, *i.e.*, by using $0{\cdot}7037 \sec \alpha + \operatorname{cosec} \alpha = 2{\cdot}900$, we obtain, instead of 2·900, the values 2·9067 and 2·9099. We now use another diagram, Fig. 3, having as abscissæ the angle in degrees and minutes and as ordinates the difference between the nominal value 2·900 and those obtained. Through the points for 67 deg.

Fig. 1.

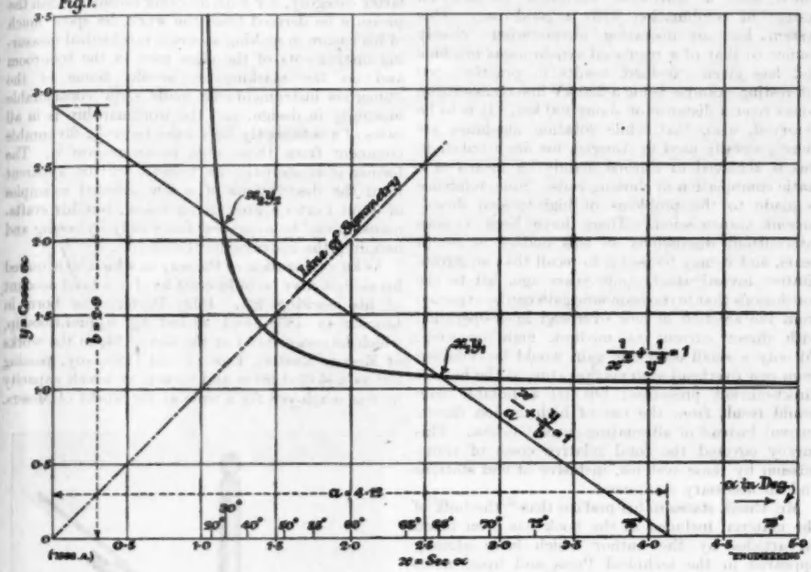


Fig. 2.

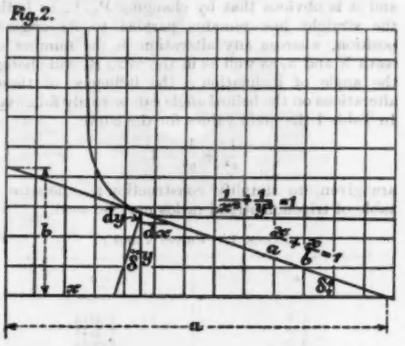


Fig. 3.

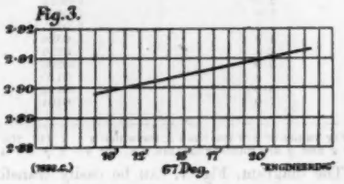
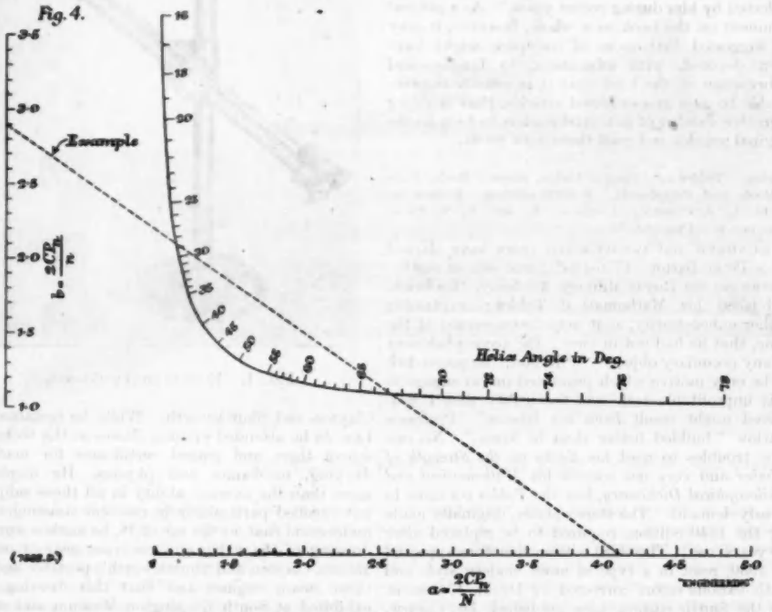


Fig. 4.



* See ENGINEERING, vol. 151, page 183 (1941).

20 min. and 67 deg. 17 min., we draw a straight line which intersects the abscissa near 67 deg. 12 min., and when using for this the correlated table values for sec α and cosec α, the main equation gives 2·9006. A somewhat better value is 67 deg. 11 min., giving 2·8995, the most probable value being 67 deg. 11·5 min. The graphical interpolation and extrapolation will not be always necessary, and it may be mentioned that, by this operation, small errors in reading the diagram are automatically cancelled out. If the first straight line does not give satisfactory results, its location can be varied and it is obvious that by changing P_n, C, or both, the straight line remains parallel to its original position, whereas any alteration in the number of teeth N and n, as well as in the ratio R, will change the angle of inclination; the influence of these alterations on the helical angle can be easily followed. In Table I the main values for the curve

$$\frac{1}{x^2} + \frac{1}{y^2} = 1$$

are given, to simplify construction; otherwise a table of trigonometrical ratios may be used.

TABLE I.—*Values x and y.*

x.	y.
1·5	1·3413
2·0	1·1548
2·5	1·0921
3·0	1·0607
3·5	1·0435
4·0	1·0328
4·5	1·0256
5·0	1·0206
5·5	1·0170
6·0	1·0142
7·0	1·0104

For values of x of less than 2, for which $y = 1·414$, the values for x and y are interchangeable, *i.e.*, for $y = 2$, $x = 1·414$.

The diagram, Fig. 1, can be easily transformed into a nomogram, consisting only of two straight scales for the values a and b, and one curved scale for the helix angle, as in Fig. 4, page 61. As the angle markings are directly on the scale, the reading is quicker, and in some instances, more accurate.

LITERATURE.

Power System Interconnection (Transmission Problems). By H. RISSIK, B.Sc. London: Sir Isaac Pitman and Sons, Limited. [Price 25*s.* net.]

THE present intense industrial activity in many parts of the world makes the transmission of electrical energy, over both short and immensely long distances, more important than ever before, and has directed renewed attention to the methods of control with a view to simplification, increased economy and greater reliability. For example, in some electro-chemical processes, such as the production of aluminium, plant is used which requires as much as 50,000 amperes, and it is essential to ensure continuity of supply and an absence of serious current fluctuations lest the bath should freeze, since heavy financial loss may result from only a few minutes' disturbance of the electrical supply. It is of great importance, therefore, that the fundamental practical problems involved in electric power system interconnections should be as widely understood as possible; but it should be observed that there is a significant distinction between the respective functions of the grid in this country and corresponding supply systems in Europe and America. In Great Britain, the main purpose of the grid is not bulk transmission of energy, but the equalisation of the load on various groups of power stations, whereas in Europe and America, transmission over long distances is of equal importance with the grouping of the systems into networks.

Mr. Rissik's book comprises six chapters, of which the first two deal, respectively, with fundamental conceptions and principles, and circle diagrams for power systems. Chapter III is concerned with the power limits of a synchronous interconnector; Chapter IV, with steady-state stability; and Chapter V, with transient stability. The concluding chapter is devoted to a consideration of the limitations of alternating-current power transmission and interconnection. There is a fairly extensive bibliography. The important problem of the dynamic stability of generators is discussed, using a well-known graphical method, and this illustrates how such a method can provide a powerful tool for the solution of a problem the mathematical equation of which is practically insoluble. Many of the conditions dealt with, however, are more immediately applicable to American operating conditions than to those in this country.

It is rather surprising to find that, in dealing with the excitation of a transmission line, the author does not refer to the automatic static method, which uses a star-delta saturated choking-coil system in combination with a condenser. This system has an operating characteristic closely similar to that of a regulated synchronous machine and has given excellent results in practice, one interesting example being a 220-kV line transmitting power over a distance of about 400 km. It is to be observed, also, that while rotating machines are more generally used in America for line excitation, this is achieved in Europe mainly by means of a static combination of choking coils. Some reference is made to the problems of high-tension direct-current transmission. There have been various intermittent discussions on this matter in recent years, and it may be useful to recall that an authoritative investigation, some years ago, led to the conclusions that (*a*) no economic gain can be expected from the erection of new overhead lines operating with direct current at medium high pressure; (*b*) only a small economic gain would be obtained from new overhead systems operating at the highest direct-current pressures; but (*c*) a notable gain would result from the use of high-tension direct-current instead of alternating-current cables. This survey covered the total relative costs of transmission by these systems, inclusive of end stations and all necessary equipment.

Mr. Rissik states in his preface that "the bulk of the material included in the book has been based on articles by the author which have already appeared in the technical Press and upon notes collected by him during recent years." As a general comment on the book as a whole, however, it may be suggested that more of its space might have been devoted, with advantage, to fundamental information of the kind that it is usually impracticable to give in specialised articles, thus enabling a greater number of potential readers to turn to the original articles and read them with profit.

Barlow's Tables of Squares, Cubes, Square Roots, Cube Roots and Reciprocals. Fourth edition. Edited by DR. L. J. COMRIE. London: E. and F. N. Spon, Limited. [Price 8*s.* 6*d.* net.]

A HUNDRED and twenty-seven years have elapsed since Peter Barlow (1776-1862), professor of mathematics at the Royal Military Academy, Woolwich, published his Mathematical Tables; explaining rather unnecessarily, as it must have seemed at the time, that he had not in view "the accomplishment of any pecuniary object." "In fact," he proceeded, "the only motive which prompted me to engage in this unprofitable task was the utility that I conceived might result from my labour." Professor Barlow "builded better than he knew." No one now troubles to read his *Essay on the Strength of Timber* and very few consult his *Mathematical and Philosophical Dictionary*, but the *Tables* continue in steady demand. The stereo plates, originally made for the 1840 edition, required to be replaced after 90 years' use. The third edition therefore appeared in 1930, reset in a type of more modern style and with various errors corrected by Dr. L. J. Comrie. In the fourth edition, now published, Dr. Comrie, who now directs the Scientific Computing Service, Limited, has extended the tables from 10,000 to 12,500, mainly with the object of avoiding discontinuities when working with numbers just below and just above unity. De Morgan's preface to the 1840 edition expressed the fear that "it must take years of trial and use of the tables to establish their freedom from error"; but in fact the errors were remarkably few. We may mention that *The Times* of July 15 recorded that Mrs. Selina Hewson, Professor Barlow's granddaughter, celebrated her 100th birthday on that day; thus two lives suffice to link the American Declaration of Independence with the Lease and Lend Act.

JOHN PORTER, CRAFTSMAN.

DESPITE the development of mass production and of other modern manufacturing methods, craftsmanship is still an essential factor in most branches of the engineering industry. In many cases its exercise brings with it a degree of satisfaction that is an important addition to any material recompense, and in some the former alone is adequate compensation for the time and trouble expended on some self-imposed task. The late John Porter, of Sheffield, must be included in this latter category, for with no other incentive than the pleasure he derived from the work, he spent much of his leisure in making accurate mechanical measuring instruments of the class used in the tool-room and on the marking-out bench. Some of the numerous instruments he made show considerable ingenuity in design, and the workmanship is in all cases of a sufficiently high order to evoke favourable comment from those able to appreciate it. The former characteristic, we believe, will be apparent from the descriptions of a few selected examples of John Porter's work given below, but his craftsmanship can be appraised fairly only by seeing and handling the instruments themselves.

As an explanation of the way in which he acquired his skill, it may be of interest to give a brief account of his working life. John Porter was born in Lincoln in 1858, and served his apprenticeship, which he commenced at the age of 14, in the works of Messrs. Ruston, Proctor and Company, passing out as a skilled fitter and turner, in which capacity he was employed for a time at the works of Messrs.

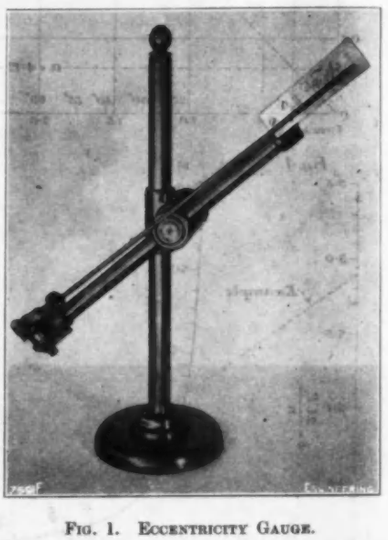


FIG. 1. ECCENTRICITY GAUGE.

Clayton and Shuttleworth. While he remained at Lincoln he attended evening classes at the technical school there and gained certificates for machine drawing, mechanics and physics. He displayed more than the average ability in all these subjects, but excelled particularly in machine drawing. We understand that, at the age of 18, he made a working drawing of the valve and governor gear of one of Messrs. Clayton and Shuttleworth's portable agricultural steam engines and that this drawing was exhibited at South Kensington Museum and afterwards purchased by the Museum authorities. At the age of 23, Porter went to the cycle works of Messrs. Humber, at Beeston, where he was employed for a few months on frame building. On leaving Beeston he went to Sheffield, in which city he spent the rest of his life. His first employment in Sheffield was at the River Don Works of Messrs. Vickers, where he was engaged as a fitter in the gun shops and was afterwards made charge hand in the tool room. While there he operated the first universal grinding machine in the Sheffield area, the machine having been installed in 1890.

Leaving Messrs. Vickers in 1911, he went to the Atlas Works of Messrs. John Brown and Company,

THE WORK OF THE LATE JOHN PORTER.

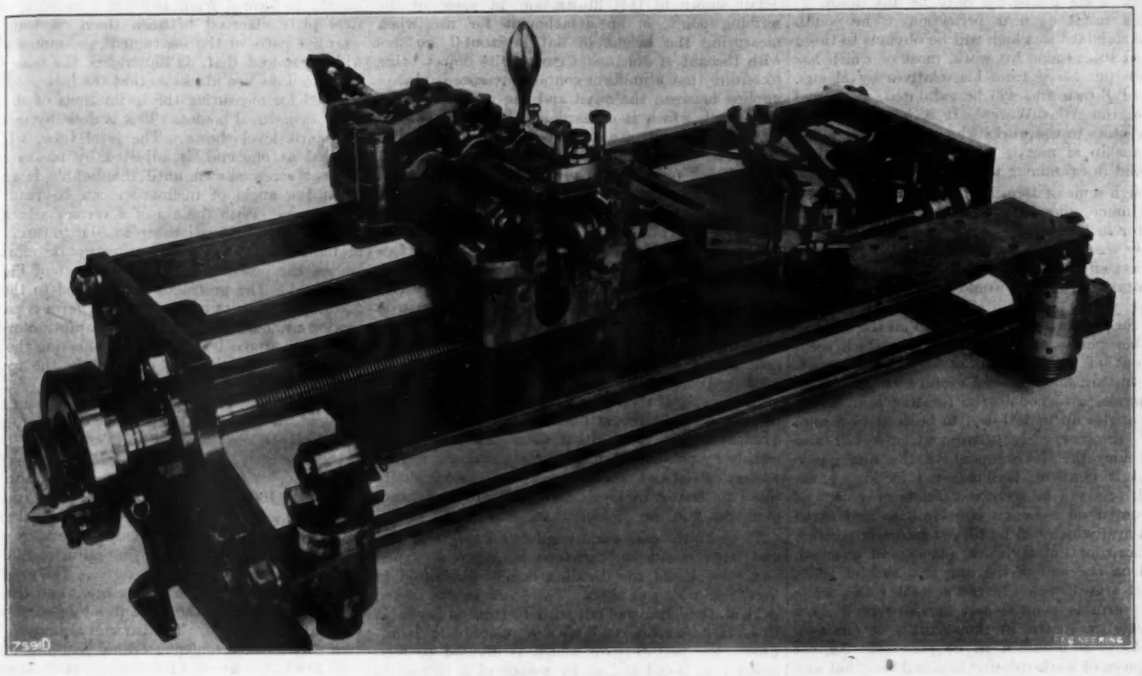


FIG. 2. FRONT VIEW OF DIVIDING ENGINE.

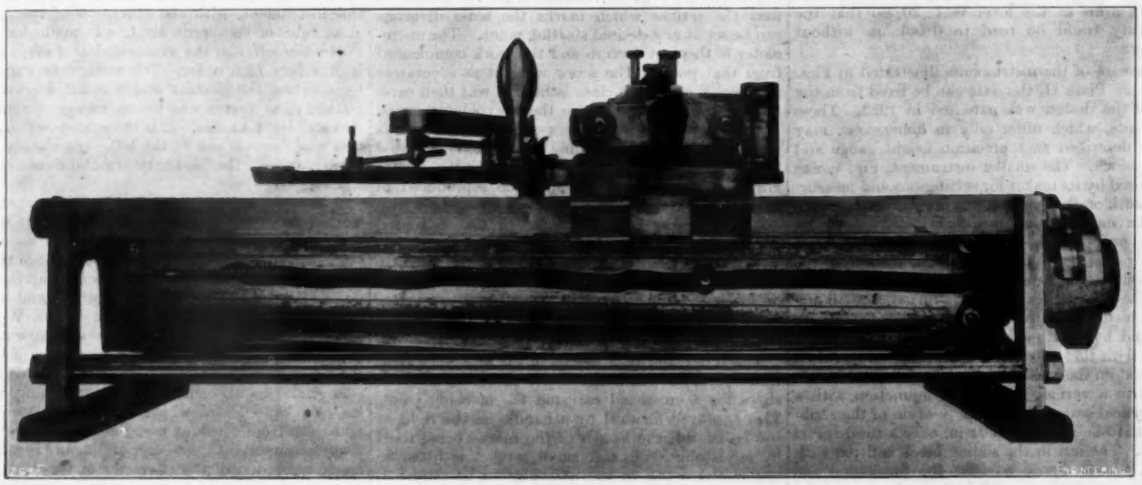


FIG. 3. REAR VIEW OF DIVIDING ENGINE SHOWING SCREW-CORRECTING CAM.

Limited, as tool-room foreman in the armour-plate department. Here he was among the first to advocate the use of carbide tips for cutting tools. At that time the tips were secured by a special brazing operation, for which Porter made and used his own flux. While in this department, where he remained until the amalgamation of Messrs. Thos. Firth and John Brown, Limited, in 1931, he designed and made a valve for controlling the flow of gas from batteries of cylinders to the oxy-acetylene blowpipes which were used on a large scale for cutting and welding operations. His work here also included the surface hardening of gear teeth by heating them individually with an oxy-acetylene blowpipe flame and quenching each one as rapidly as possible. This, we believe, was a novel process at the time. After the amalgamation, Porter was moved to the nitriding department in the Atlas and Norfolk Works of Messrs. Firth and Brown, his work being to make careful measurements of parts before and after the nitriding operation and to record the small changes in dimensions which occur as a result of the treatment. He was well fitted for work of this character, which demands considerable skill and care, and he carried it out to the complete satisfaction of his employers until his health failed in November, 1940. His death occurred on February 21, 1941.

John Porter's working life was thus by no means unique. Thousands of mechanics in Yorkshire, and in other parts of the country where engineering is the staple industry, have obtained, and are still obtaining, their livelihoods in a similar manner. Many, doubtless, find recreation as he did in some form of craftsmanship and these will readily appreciate his motives for exercising and developing his skill. John Porter's instruments were designed and made by him mainly in his own home with hand tools of his own manufacture, although some of the work was done at odd times in the shops. He had no lathe of his own, but while employed by Messrs. Firth and Brown had access to the high-class Pratt and Whitney and Reinecker lathes which formed part of the equipment of his workshop, and made good use of these tools.

As already mentioned, Porter was a good draughtsman and it was his practice to make careful drawings of his instruments before commencing work on them. He acquired in his early days sufficient knowledge of mathematics to enable him to work out his own designs in detail and knew enough about the practical metallurgy of ferrous and non-ferrous metals to guide him in selecting suitable materials for the various parts and in modifying their properties by heat treatment to meet his somewhat exacting requirements. Thus it may be said that the instruments he made were his own work in all respects. Unfortunately, we are not able to deal with them in accurate chronological order, as no record of the dates of production has been kept.

Neither can we state the time occupied in making them, which would be of considerable interest. Porter himself gave no thought to the time expended, being influenced only by his desire to achieve a result as near perfection as he could. That his standard was high will be obvious to those privileged to examine his work, most of which has now been purchased from his relatives by Messrs. Firth and Brown and will be exhibited, in normal times, in the Atlas Works. It is felt that those future visitors to the works who can appreciate fine craftsmanship in metals will not regard the time they spend in examining the exhibit as wasted.

Although some of John Porter's early instruments bear his name, none is dated. A steel semi-circular protractor included in the collection, however, has obviously seen much service and is probably one of his earliest efforts, as it bears a certain amount of ornamentation that he would not have added in his later years. A creditable sketch of Conway Bridge, for instance, has been etched on the surface, with other purely ornamental devices which seem rather out of place according to modern views. The protractor, however, is a useful instrument and has a vernier attached to the rotating arm, which enables angles up to 180 deg. to be read to 4 min. of arc. Another early instrument, designed and made before the development of the dial gauge rendered it obsolete, is illustrated in Fig. 1, on page 62. As will be seen, it consists of a vertical rod mounted on a heavy circular base and fitted with an arm which can be turned into any position in the horizontal and vertical planes and clamped. Pivoted on one end of the arm is a slender lever, the short arm of which carries a small roller, while the long arm is pointed and moves over a short fixed scale graduated in thousandths of an inch. The roller was intended to be placed in contact with a piece of work rotating in a lathe so that any eccentricity could be measured by the movement of the pointer over the scale. The ratio of the short and long arms of the lever is 1 : 20, so that the eccentricity could be read to 0·001 in. without difficulty.

In the case of the instruments illustrated in Figs. 4 and 5, on Plate II, the date can be fixed from the fact that the design was patented in 1922. These instruments, which differ only in dimensions, may each be described as a precision height gauge and scribing block. The smaller instrument, Fig. 5, was largely used by its maker for setting-out and measuring off work on the marking-out table, the larger one, Fig. 4, having been employed principally for demonstration purposes in connection with his patent. Referring first to Fig. 4, it will be seen that the instrument consists essentially of a steel base-block to which two vertical rods are fitted. A sliding block, which carries the scribing point, is fitted with a nut and by rotating a long vertical screw which engages with this nut the sliding block can be raised or lowered on the vertical rods. The sliding block is fitted with a vernier which, in conjunction with a fixed vertical scale, enables the position of the scribing point to be read to 0·001 in. over a total travel of 12 in. The nut in the sliding block is fitted with a quick-release device so that the block and the scribing point can be moved freely by hand, and the block can be fixed in any position by means of a clamp operated by the milled-head screw seen on the left of the block in Fig. 4. The main vertical screw has 10 threads per inch, of Acme form, and is fitted at its upper end with a micrometer collar reading to 0·001 in. to enable the position of the scribing point to be adjusted without reference to the scale and vernier. It will be noticed, also, that the sliding block is fitted with a collet in which is held an eccentric head carrying the scribing point. It is thus possible, by slackening the collet and rotating the head, to bring the point into coincidence with a line scribed on the work without moving the sliding block as a whole. This arrangement is very convenient when it is required to measure the vertical distance between two scribed lines.

The smaller instrument is similar in principle to that just described, but the vertical travel of the scribing point is only about 5 in. The measuring screw, in this case, is $\frac{1}{2}$ in. Whitworth with 20 threads per inch. Five sets of scales and verniers, reading, respectively, to 0·001 in., 0·01 in., $\frac{1}{64}$ in., 0·2 mm., and 0·02 mm., were made for use with this instrument and can be seen in Fig. 5, one in its normal position and four in the foreground. An interesting detail shown in this illustration, in place of the scribing point, is an attachment for use when measuring the height of flat horizontal surfaces with the aid of Johansson gauges, its object being to ensure that a uniform contact pressure is always applied between the anvil and the work or gauge. The anvil, which is of hardened steel, is mounted at the outer end of a lever, which is pivoted to a steel-plate body mounted in the collet in place of the scribing point. Also pivoted in the body is an indicating lever, the short arm of which rests on the lever carrying the anvil, contact between the two levers being maintained by spring pressure. The long arm of the indicating lever terminates close to a fixed sharp-edged abutment formed on the body of the attachment, and the arrangement of the components is such that any relative movement between the anvil and the body is transmitted to the free end of the indicating lever and magnified in the ratio 10 : 1. In making a measurement, the contact pressure between the anvil and the work is adjusted until the end of the upper surface of the free end of the indicating lever is flush with the top of the fixed abutment, a condition which can be detected readily by passing the finger lightly over the closely adjacent fixed and movable surfaces. A surprisingly small difference in level, and therefore of contact pressure, can be detected in this way.

To make the scales and verniers for height gauges and other measuring instruments, Porter designed and constructed the dividing engine illustrated in Figs. 2 and 3 on page 63. The screw in this engine is 21 in. long and was cut with 10 threads per inch. It is fitted at one end with a micrometer hand-wheel, the periphery of which is divided to read directly to 0·001 in., or by means of a vernier to 0·0001 in. A knurled nut is provided to enable the micrometer to be released from the screw, so that the scriber which marks the scale divisions can be set at any desired starting point. The micrometer is then set to zero and the work commenced from that point. The screw was cut as accurately as possible on a high-class lathe and was then carefully measured to determine the unavoidable errors. From these measurements a correcting cam was made in two corresponding parts and mounted behind the screw, as clearly shown in the photograph of the back of the machine reproduced in Fig. 3. In use, a roller mounted on a short arm attached to the nut runs between the contoured edges of the two parts of the cam, so that as the nut moves longitudinally it is rotated slightly about the axis of the screw, thereby increasing or decreasing the effective pitch. In this way any errors in pitch are practically eliminated. This method of correcting screw errors is, of course, well known.

The screw and cam are mounted in a very rigid framework, of which the upper members serve as slides for a crosshead carrying the marking point. This is moved forward by a handle on the right of the crosshead, the length of the marks being fixed by adjustable stops. A small ratchet is fitted to enable the depth of the markings to be adjusted, and a quick-acting trigger is provided to lift the marking point clear of the work during each return stroke. The work is mounted on a table in front of the machine extending for the full length of the screw, the table having a number of tapped holes for fixing the work, as can be seen in Fig. 2. The table can be tilted for dividing the bevelled edges of verniers, etc., and can be raised or lowered, to suit work of different thicknesses, by micrometer screws at each end. A pantograph attachment for engraving figures, etc., can be bolted on to the crosshead and is shown in position in Fig. 2. The maximum reduction obtainable with this attachment is one-fifth of the size of the copy. It may be mentioned here that this machine has been employed recently in Messrs. Firth and Brown's works for dividing the scales for a slide rule required for a special purpose. It was found to be convenient to use and to give excellent results, which are an effective tribute to the high-class workmanship employed in its construction. The machine, we think, must be regarded as John Porter's masterpiece.

One other piece of work of which he was justly proud is the angle comparator, illustrated in Fig. 6, on Plate II, which was used for setting-up or measuring angles. The base bar, which is about 12 in. in length, is formed from two angle sections with a steel plate clamped between them on which the essential parts of the instrument are mounted. It will be noticed that, as illustrated, the base bar is supported on Vee blocks so that the instrument can be used for measuring the inclinations of shafts or other cylindrical bodies. This is done by means of the spirit level shown. The level tube, which is pivoted at one end, is adjusted by means of the tangent screw shown until the bubble is central, when the angle of inclination can be read on a fixed scale. With the aid of a vernier attached to the level tube inclinations up to 40 deg. can be read in minutes of arc. For setting up or measuring angles, the protractor seen on the left of Fig. 6 is employed. The protractor is attached to the steel plate by two pairs of levers which form a parallel-motion mechanism and enable the protractor to be raised or lowered bodily without affecting the angle setting; it can then be clamped in the required position in the vertical plane.

The angle bar of the protractor fits into a circular plate which is pivoted to the body of the protractor and can be turned about a horizontal axis. On the bevelled edge of the circular plate is a scale of angles, having an intermediate zero, the graduations reading to 160 deg. in one direction of rotation and to 90 deg. in the other; by means of a fixed vernier attached to the protractor body the angles can be read to one minute of arc, fine adjustments being made by means of a tangent screw. The graduated plate can be clamped in any position and the angle bar can be fitted in the plate in either of two positions at right angles. The bar can be moved longitudinally to a convenient working position and then held firmly by an eccentrically operated clamp, the clamping block of which fits into a groove in the bar clearly visible in the illustration. Every part of this instrument, with the exception of the curved glass tube of the spirit level, was made by John Porter himself, and the workmanship of every detail is of a very high order. The method he employed for dividing the circular scales is not known with certainty, as Porter was by no means communicative and left no notes. It is thought, however, that this was done on one of the lathes previously mentioned, using the ordinary machine-cut change wheels.

A few other items of John Porter's spare-time work were an adjustable micrometer frame with a series of bushed holes enabling the range to be extended in steps from 1 in. to 6 in.; a large vernier callipers with jaws 6½ in. long, measuring up to 15 in. on one side and to 38 cm. on the other; and sets of plug and ring gauges and Johansson gauges. We may mention, however, that he was a craftsman in materials other than metals. He carved, for instance, a remarkable set of chess men in box-wood and ebony, and he also succeeded in repolishing one of his own hand lenses which had become scratched and worn from constant use. This latter, and relatively unimportant, piece of work is only mentioned as an indication of the character of the man. His first attempts were failures, but, refusing to admit defeat, he studied books on glass grinding and polishing obtained from a library and was able, with the knowledge thus acquired, to restore the worn surfaces of his lens so that it was "as good as new." These then were the most marked traits of John Porter's character; he would spare neither time nor trouble to remove any obstacle that impeded his work and he did not regard that work as finished until it was, in his opinion, perfect. There is room in this country now for many more John Porters, and it is safe to prophesy that there always will be.

COMMERCIAL JOURNEYS ABROAD.—United Kingdom firms who desire to apply to the Department of Overseas Trade for recommendation in support of applications for exit permits for commercial journeys abroad should, in future, communicate with the Department of Overseas Trade (Exit Permit Section), Millbank, London, S.W.1 (Telephone: WHItehall 9040). The address should be given in full in all communications, both on the envelope and at the head of the letter.

THE WORK OF THE LATE JOHN PORTER.

(*For Description, see Page 62.*)

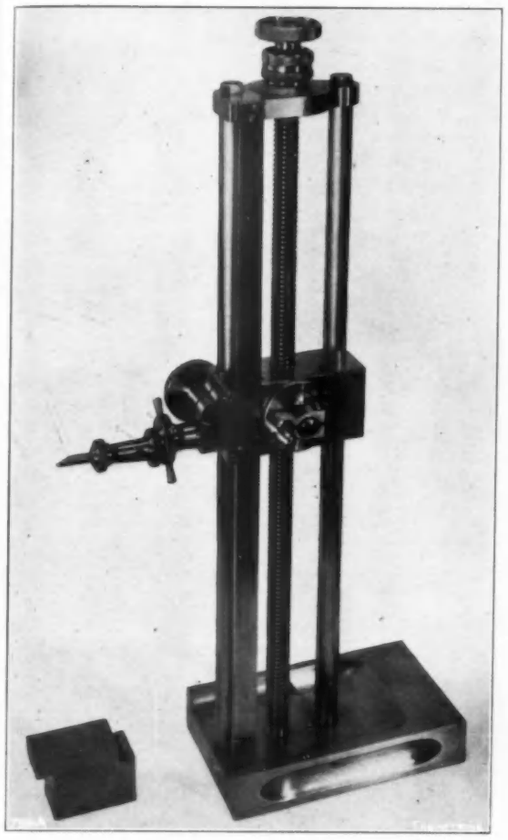


FIG. 4. PRECISION HEIGHT GAUGE AND SCRIBING BLOCK.

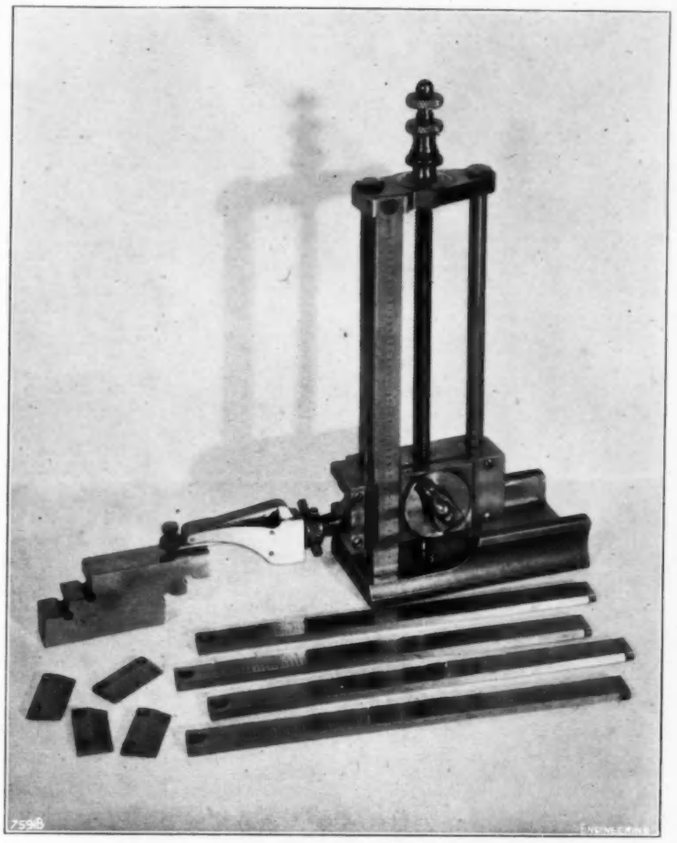


FIG. 5. PRECISION HEIGHT GAUGE WITH PRESSURE-INDICATING ATTACHMENT.

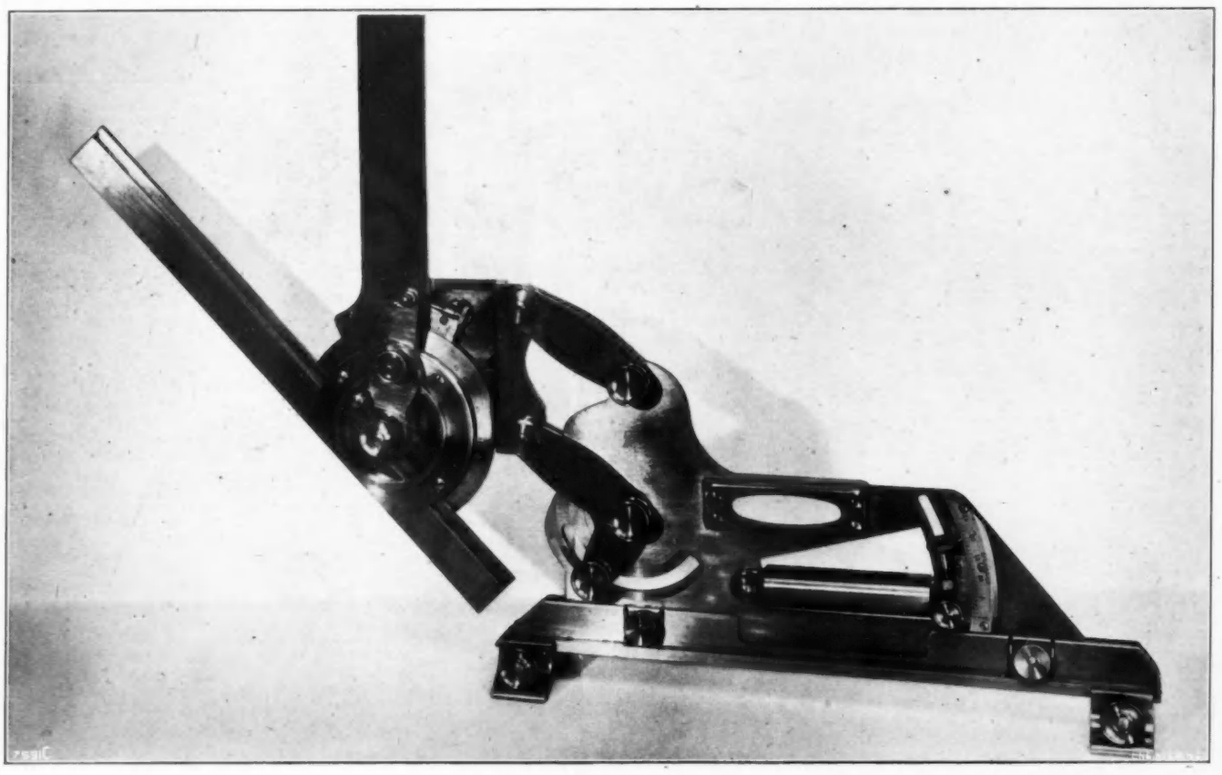


FIG. 6. ANGLE COMPARATOR.

(*To face page* 64.)

RESEARCH IN CANADA.*

By LIEUT.-GENERAL A. G. L. MCNAUGHTON, C.B., C.M.G., D.S.O.

IT is to your precept and example in 1916, in the organisation of the Honorary Advisory Council for Scientific and Industrial Research, and the suggestion then made by the Government of the United Kingdom to our Government, that Canada should set up a similar body, that we trace the genesis of our own National Research Council. In the year 1916, we were in the earlier phases of the first World War and it had taken the impact of that event to shake the British peoples, both here and in the Dominions, from their complacency as regards research. Previously we had left research mostly to the universities, where its results as "pure science" were made available impartially to all, for the benefit of friend and foe alike. On the other hand, in industry, where mutual help would have been of great advantage, whatever each company was able to develop in the way of new apparatus, materials and processes was regarded as a trade secret, to be jealously kept to themselves, and particularly to be denied to other firms in similar business in their own country, though not necessarily to foreign associated companies.

Contrast this situation with that existing in Germany, where research—pure, applied, and industrial—had very early been recognised as a matter of profound concern, and where its organisation and correlation had been taken under the auspices of the Government itself. Under this meticulous care, every idea and invention was seized upon and subjected to intensive development at the hands of comprehensive groups of trained scientists; eager business men stood ready to exploit whatever they produced. There are many who will remember how this, and neglect on the part of other nations, had reacted to the great advantage of German world trade and so to the creation of a vast potential for munitions production in war. You know also of the great difficulties which faced the Allies on the outbreak of hostilities by reason of the German monopolies. The German dye industry, for example, which had taken the invention of a British chemist and turned it into a great commercial undertaking, led directly to efficiency in the production of explosives and of poison gas. I have often wondered why this menace was suffered to develop without adequate counter measures being taken, and it seems, on looking back, that its very gradualness must have been the answer, men's minds becoming accustomed to it by degrees.

Once started, British research in its relation to the war effort of the country developed rapidly and effectively, and at the end of the first World War it could be said with truth that one of the essential contributions to victory had been made by British and Dominion industry, once scientific and industrial research was organised and brought into play. To illustrate what was accomplished in Great Britain I mention a few significant facts. In 1914 there was no optical glass industry in the United Kingdom. Germany and Austria had a practical monopoly in this field, and even the lenses of the sights of British guns were imported. Organisation of the scientists, followed by extensive basic and applied research, corrected this situation. To-day, the optical glass produced in Britain is of the finest quality in the world. I mentioned poison gas—chlorine—a product of the German chemical industry which was used against the French and the left flank of the First Canadian Division on April 22, 1915. The Germans used it against us thinking that the Allies would not be able to reply in kind (they were contemptuous of our scientific organisation), but by the summer of 1918, as a result of organised research, our chemical industries were producing mustard gas by a new process at a rate many times that which had been found possible by Germany.

The National Research Council and its Development up to 1939.—As I have said, the organisation of research in Canada as a function of Government dates back to 1916, when we followed your example and set up an Honorary Advisory Council for Scientific and Industrial Research. It was not contemplated then that this Council would establish laboratories of its own; it was to act as an agency for consultation and co-ordination between those already carrying on research in the existing laboratories of the several departments of the Dominion and Provincial Governments, in the universities, and in industry. To give you some idea of the very limited facilities then available: a report prepared at the time indicates that the total annual expenditure on research in all Government laboratories, both Dominion and Provincial, amounted to considerably less than 100,000 dols., and that of some 2,400 leading Canadian firms engaged in manufacturing which replied to the questionnaire sent out, only 37 possessed laboratories which even pretended to engage in research work.

Looking back at the history of the Honorary Advisory Council for Scientific and Industrial Research, in the war and early post-war periods, it is remarkable what was accomplished with the limited facilities at their disposal, but it is not to be wondered at that men who were informed on the subject should have realised the utter inadequacy of the provision which had been made and that they should have pressed for some improvement. As a result of the pressure of public opinion which developed, the matter was repeatedly considered in Parliament, and eventually the Research Council Act was passed in 1924, following in very close detail a draft which had been prepared by a non-party committee representative of both the Senate and the House of Commons. The Council's main laboratories, located at the junction of the Ottawa and Rideau Rivers, were commenced in 1930 and opened at the time of the Imperial Economic Conference in 1932.

As was perhaps to be expected in the era following the Armistice of 1918, it was very difficult to obtain adequate funds for scientific and industrial research. While the need for co-ordination of this work as a war-time measure had been evident, recognition of the equally vital needs of competitive industry in peace-time came only very slowly until 1935, when the Government, despite the depression then raging, saw fit not only to double the current appropriation, but to provide substantial sums on capital account to complete the equipment of the laboratories. These increased appropriations were maintained by succeeding governments and steadily increased until, by 1939, the Council's annual budget on current account was somewhat over 1,000,000 dols. Meanwhile, an even more striking increase had taken place in the facilities in Canadian industry itself, and by 1938 it is estimated that these comprised upwards of 1,000 industrial laboratories for research testing and plant control, with some 2,500 professional workers employed full time. Similarly, in the Dominion Departments of Agriculture, of Public Works, and of Mines and Resources the last two decades have seen the creation of a number of research and testing laboratories related to their special functions and duties, all of which represent a very substantial asset. Elsewhere the most notable addition was the Ontario Research Foundation, which operates in the most friendly relation with the National Research Council.

In 1938, provision for a further large group of laboratories, to provide the Council with additional facilities, particularly for aeronautical engineering, hydraulics, and high-voltage electrical engineering, was sanctioned by the Government. Construction was started in 1939, and is now advanced to the point that in some cases the buildings are in occupation. As a result of these measures, we had in Canada at the outbreak of the present war, in physical existence, the laboratories and trained staffs competent to act as a nucleus in undertaking the study of the problems presented in almost every field of war requirements, both within the sea, land and air forces themselves, and also in the industrial life of the country as it had to be re-oriented to produce the vast and complicated supplies needed in transition from peace to war basis.

I have been speaking of the actual research equipment of Canada, in the way of Government and industrial laboratories, as it stood at the outbreak of the war with a view to indicating the very favourable position in comparison with the situation on the previous occasion when we had to take up arms against Germany. But the adequacy of physical equipment and technical staff is only one side of the question, and what is probably equally important as an asset is the organisation of the Council itself as a going concern and the intimate relations which had been developed with every branch of science in Canada; with universities; with industry; with departments of the Dominion and Provincial Governments concerned with research problems; with the great professional societies in medicine, engineering, forestry, etc.; with the Canadian Engineering Standards Association in the field of industrial standardisation, and with many other organisations.

The National Research Council consists of fifteen members selected for terms of three years from among men prominent in scientific work in Canadian universities or in Canadian industry. The Council is required by statute to meet at least four times annually in Ottawa. There is a president, appointed by the Governor in Council for a term of years, who reports directly to the Privy Council Committee on Scientific and Industrial Research of which the Minister of Trade and Commerce is the chairman. The office of president is now filled by Dean C. J. Mackenzie, M.C., of the University of Saskatchewan, an eminent civil engineer who served with the Canadian Forces in the last war. The Council's membership is broadly representative of all parts of Canada, and includes persons qualified to speak with authority in education, science, industry, business and finance. Apart from administration which is organised much on the usual lines of a department of Government, the staff of the Research Council is grouped in a number of divisions, each of which is under a director.

The divisions of physics and electrical engineering, chemistry, mechanical engineering, including hydraulics and aeronautics, biology and agriculture, are responsible for the direction and conduct of the technical work in the fields indicated by their designations. There is a section on research plans and publications concerned with the collection, collation and issue of scientific information and with the general development of co-operative investigations through committees, etc. There is also a section on codes and specifications, matters which are in the highest degree important in relation to mass production in war. Provision is made for the closest co-operation and collaboration between all branches concerned in any particular problem. One of the great advantages possessed by an organisation such as the Council's own laboratories, with their comprehensive representation of all branches of science, is that experts in every line required can be brought together at short notice to study a problem and to work as a team for its solution. This facility is very important, for in most research problems related to industrial or agricultural production or processing we are usually confronted with limiting factors of many kinds, and it is not easy to determine in advance in which branch of science the answer should be sought.

Associate Committees and Co-operative Research.—Under the wide responsibilities placed upon the Council by Parliament, there is a duty to bring about the best possible use of all the country's facilities for research, of which the Council's own laboratories now represent only a small part. In order to bring to bear the knowledge of scientific men in other institutions and in industry and to correlate the work of research in all organisations concerned, a number of so-called "associate committees" have been set up. The function of these committees is to direct co-operative research on the problems assigned to them; to settle the objectives; to indicate the individuals or organisations which should undertake the several component parts of the inquiry; to receive and co-ordinate the resulting information, and to make it available to those who will turn it to advantage. The Council endeavours to ensure that these committees are comprehensively representative of all interests, and we expect them, each in their proper sphere, to form a national plan into which all who are in a position to contribute information can fit their own particular lines of research. The actual investigations are carried out, not only in the Council's laboratories, but in the laboratories of the various universities, Government departments and industrial institutions throughout the country. I cannot too strongly stress the fact that much of the initiative in these committees lies with the outstanding experts from other organisations who have associated themselves with the National Research Council in this work.

Time does not permit me to recite to you the long list of these associate committees or to go into, in any detail, the important tasks which they are carrying out for Canada. But, in order to give some picture of the wide range of work involved, I should like, by way of illustration, to mention one or two in several diverse fields. In agriculture I would mention the committees in charge of grain research and of transport and storage of food—these, both by reason of the great importance of the subjects and also on account of the very substantial results which have been achieved in comparison with the trifling expenditures of money which have been made. In forestry, I would mention the committee, organised in co-operation with the forest service of the Department of Mines and Resources.

This Committee has concerned itself with such matters as the study and mitigation of forest hazards, through fire, insects and other pests, and the preparation of a manual giving advice as to the management of the "farmers' woodlot," a most important source of raw material. This manual is now in general use in the Maritime Province and Quebec. I could continue with examples of the work of many other associate committees in the fields of medicine, chemistry, physics and engineering; of the detailed and exacting work carried out by our joint committees with the Department of Finance in the preparation of a National Building Code for Canada, which is now, despite the war, in process of publication, and which should bring order into a situation which, under the conflicting jurisdictions of municipality, Province and Dominion had become most seriously confused to the disadvantage of the public. I could cite also the work on industrial codes and specifications carried out by the Canadian Engineering Standards Association, which is a body intimately related to the National Research Council, and serves Canada as the counterpart of the British Standards Institution in this country.

(To be continued.)

* Paper read before the Royal Society of Arts on April 13, 1941. Abridged.

AIR-RAID SHELTER AIR PURIFICATION.

MESSRS. ANDAMITE, LIMITED, LONDON.

FIG. 1. SINGLE-FILTER PLANT FOR 50 PERSONS.

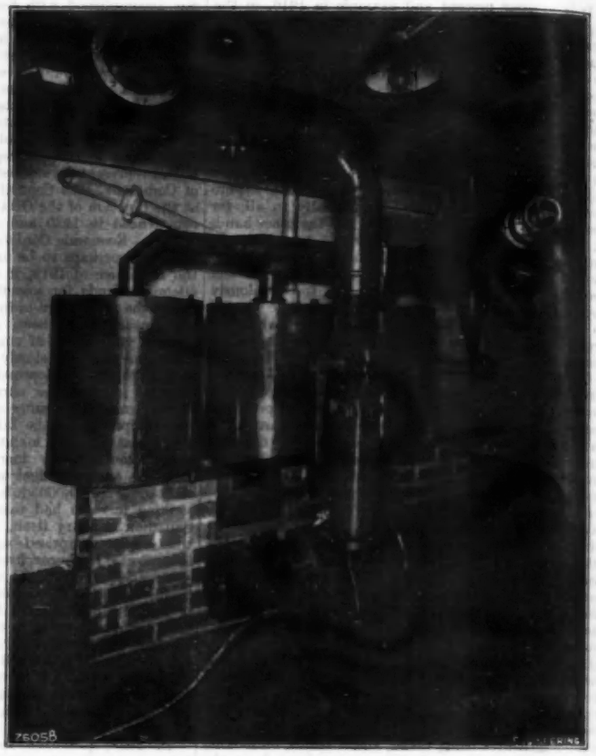


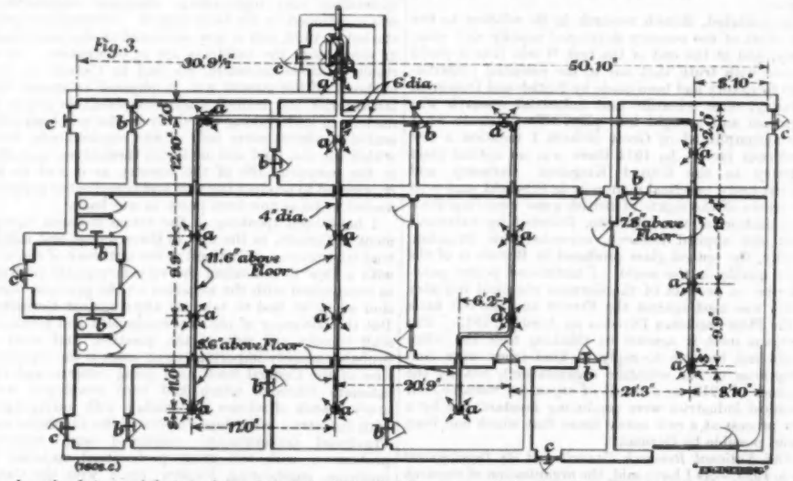
FIG. 2. THREE-FILTER PLANT FOR 150 PERSONS.

AIR-RAID SHELTER AIR PURIFICATION.

A CHARACTERISTIC of air-raid shelters, A.R.P. control rooms, first-aid rooms, de-contamination centres and similar buildings imposed by enemy action on peace-time activities, is the general absence of external openings. Such buildings may be situated underground or, when located above ground level, may be covered by masses of earth. Further, many of these buildings must accommodate, during an air raid, a number of persons in excess of normal inhabited room capacity. All these conditions postulate a system of artificial ventilation, which, in itself, is not difficult to install, but is liable to be worse than useless if the external atmosphere should be contaminated with poison gas. What is required, therefore, is a system which will be effective both when dealing with normal air and contaminated air and can be rapidly changed over from one to the other. It is claimed that the stream ventilation system developed by Messrs. Andamite, Limited, 52, Ebury-street, London, S.W.1, meets these requirements, and the description given below, together with the illustrations, Figs. 1 to 3, on this page, and Figs. 4 and 5, opposite, should therefore be of interest.

Of these views, Fig. 1 shows the air-circulation plant for a small installation capable of serving a shelter designed to hold 50 persons, while Fig. 2 shows a plant for a shelter holding 150 persons. The cylinders prominent in both views are filters for use when poison-gas is present outside the shelter, there being one filter in Fig. 1 and three in Fig. 2. A typical lay-out for a works' cleansing station, situated in the Midlands, is illustrated in Fig. 3, and two drawings of the plant for a fire station at the same works are reproduced in Figs. 4 and 5. In these two latter plants there are two filters, the designed capacity of each installation being 100 persons. In all cases the filter can be by-passed when gas-contaminated air is not being handled and the air inside the shelter is maintained at a pressure above that of the atmosphere of up to 1¼ in. water gauge, by means of an electric fan having manual operating gear for use in case of failure of the current supply. This ventilation by pressure ensures that, should the shelter crack under bombardment, no gas-laden air will enter through the cracks. The control of the air is positive and the building can be used for any length of time, while it is claimed that the 150 cub. ft. of filtered air provided per person per hour enables the shelter space per person to be reduced by one-third of that required in a naturally-ventilated room, thus decreasing costs in the case of a new building. The plants are standardised in four sizes and, though larger ones can be supplied, it is recommended that any increase in demand above the capacity of the three-filter size should be dealt with by duplication of smaller units, for fairly obvious reasons.

Fig. 3.



The assembly of a unit can be followed from Fig. 1. The cylindrical filter is clearly distinguishable, and in front of it is the fan casing with the fan axis vertical and the driving motor below. Interposed between the fan casing and the motor is a gearbox with gears to maintain the speed of the fan when operated manually. The projecting shaft at the left of the gearbox takes a crank-handle lever, with a slipping clutch similar to a motor-car starting handle. The fan is electrically driven at a speed of 2,850 r.p.m., which requires about 35 r.p.m. of the handle. The impeller has forward-curved blades and is statically and dynamically balanced. The rated output can be delivered against a total resistance of 8 in. water gauge. All shafts run in ball bearings and the gears, which have precision-cut teeth, run in an oil bath. For the larger sizes of unit, a slightly different arrangement is used, the fan axis being horizontal and the hand-operating gear being carried on a pillar and having two crank handles. This arrangement is shown in Fig. 2, in which, as well as in Fig. 1, it will be clear that the whole driving gear is enclosed. It should be understood that the arrangements illustrated in Figs. 1 and 2 are not invariable, the system being very flexible as regards assembly in order to render it suitable for installation in confined spaces.

The filter by-passing pipes are best understood with reference to Figs. 4 and 5. The air inlet is seen at *a*. It is surmounted by a dust filter consisting of a tightly-wound drum of fine-mesh expanded metal attached

AIR-RAID SHELTER AIR PURIFICATION.

MESSRS. ANDAMITE, LIMITED, LONDON.

Fig. 4.

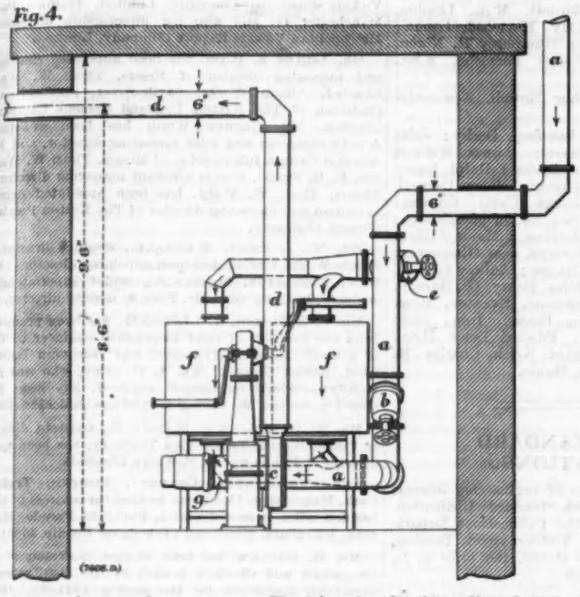
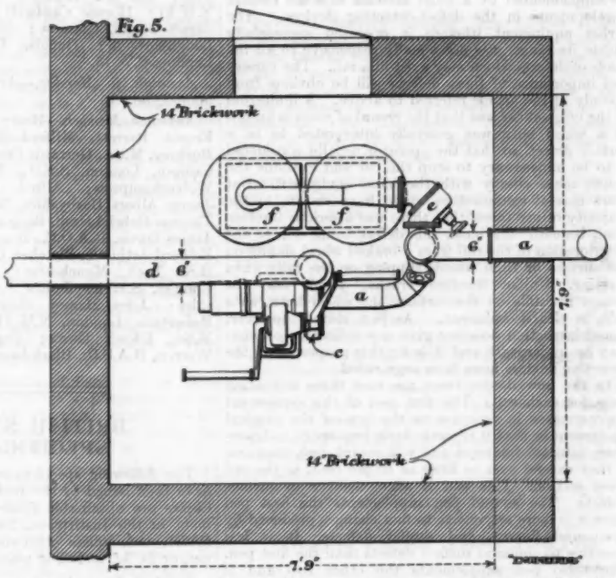


Fig. 5.



to a bottom flange and a top cover. The inlet pipe is usually fitted with a condensate cone having a drain cock. Such a fitting is visible on the right hand in Fig. 2. Returning to Figs. 4 and 5, it will be seen that the inlet pipe is interrupted by a shut-off valve *b*, the pipe then continuing to the fan casing *c*. The discharge pipe *d* leads from the fan casing upwards and then in a horizontal direction. Fitted to one side of the air-inlet pipe is a second shut-off valve *e*, from which a pipe branches to both gas filters *f*. A branched pipe *g* leads from the bottom of the filters to the inlet pipe *a* at a point below the valve *b*. When the system is being run with uncontaminated air, valve *e* is closed and valve *b* is open, the filters, therefore, being cut out of the circuit. No valve on the filter outlet is necessary, since a vacuum is induced in the filters. When gas-laden air is being handled, valve *b* is closed and valve *e* is open, so that the air is drawn through the filters.

Each filter consists of two sections in a heavy steel shell. The incoming air first passes through a thick layer of asbestos merino wool, which removes all greasy smokes and arsenical irritants. It is then drawn through closely-packed activated carbon in the form of small granules, this material absorbing all the poison-gases considered likely to be used in war. The internal parts of the filters are protected by an anti-corrosive compound and are arranged so that the air is evenly distributed throughout the filtering medium. The fittings on the pipes may now be referred to. The control valves *b* and *e* are of the screw-down type with an unribbed mushroom disc floating on the spindle. There is no hole through the disc at the point of attachment of the spindle and disc, and the seat faces are flat and finished by grinding. The body is in two parts with the flange set at angle of 45 deg. to the spindle axis, which design, since the flanges have four equally-pitched bolts, enables the inlet and outlet flanges to be arranged in a variety of planes relative to one another. The shut-off valves, one of which can be readily identified in Fig. 1, are painted with distinctive contrasting colours so that there is no likelihood of confusion in operation. Normally, however, valve *e*, painted red, prominent in Fig. 1, is sealed in the closed position and should not be opened unless a gas attack is signalled, the object of this procedure being to preserve the efficiency of the filter material which would be affected by the passage of air through it. Before breaking the seal of valve *e*, however, valve *b* should be tightly closed. Valve *b* is painted yellow.

In Fig. 1, the outlet valve for excess pressure, known as the "over-pressure valve," is seen on the air-tight door communicating with the exterior of the shelter. This valve is a disc with a ground face closing on to a ground seating. It is carried on a U-shaped lever pivoted on the seating frame and has an ingenious adjustment. The cross member of the U is slotted and a pair of balance weights on a bolt slides in the slot. The position of the weights in the slot alters the centre of gravity of the valve disc and lever and the valve can be thus adjusted to open outwards at any pressure between $\frac{1}{4}$ in. and $\frac{3}{8}$ in. water gauge. A small lever-operated cam locks the valve in the closed position should the necessity arise. The over-pressure valve, of course, only regulates the pressure desired in the shelter; it plays no part in the distribution of the air in the several rooms, this being the function of the diffuser valves, two of which are visible on the underside of the fan delivery pipe in Fig. 1, and one in the same position in Fig. 2. The valve consists of a saddle, of suitable radius for the delivery pipe, with a crossbar carrying a stud on which rotates a plain disc with finger grips. The air is diffused in a horizontal sheet, the amount being determined by the distance the valve is screwed open. A lock nut on the stud holds the valve in the required position.

The volume of the air delivered through all the diffuser valves is ascertained by an aerometer. This instrument, visible near the fan in Fig. 1, consists essentially of a glass tube containing a light float. The casing is mounted on an orifice plate in the fan delivery and the tube, above and below the float, communicates with holes on each side of the orifice, the pressure differential maintaining the float at a mark on the casing while the plant is working satisfactorily. The air pressure is indicated by the dial gauge seen on the right in Fig. 1. It shows the difference between the pressure inside and outside the shelter. The gauge is graduated to read from zero to $1\frac{1}{2}$ in. of water and is of the diaphragm type, reading to $\frac{1}{4}$ in. water gauge. The final fitting is a rotating louvre valve, the seating faces being ground. It is hand-operated and, when closed, is completely gas tight. It is used for controlling the flow of air from one room to another, or, in the case of gas-proof shelters, into the air-lock.

The disposition of the several fittings is best seen from the layout of an actual shelter shown in Fig. 3. This shelter is designed for 100 persons and is divided into a number of compartments. The diffuser valves, of which there are 16, are indicated at *a* in this illustration, and the rotating louvre valves, of which there are 10, at *b*. There is an over-pressure valve on each outer door, except that of the large compartment for a fire engine on the extreme right. There are 67 ft. of piping, 6 in. in diameter, and 167 ft. of 4 in. diameter piping, besides various bends. The inlet pipe is not included in the above figures; it is of asbestos, 6 in. in diameter. The operation of this shelter would be as follows:—When there is no gas about and the shelter requires ventilating, the motor is started by push-button operation, the yellow shut-off valve and all the diffuser and over-pressure valves being open. When the motor has run up to speed, the diffuser valves are adjusted until the float of the aerometer remains level with the mark on the casing, indicating that the correct amount of air is being delivered. The pressure gauge is then opened to the external atmosphere. The over-pressure valves are next adjusted by the balance weight until they all assume the same angular position with a reading of not more than $\frac{1}{2}$ in. water on the pressure gauge. Any levelling-up of the pressure in the different rooms of the shelter is effected by adjustment of the rotating louvre valves.

For consistent running, the pressure gauge and aerometer must be watched. A fall on the pressure gauge without a fall in the aerometer reading indicates that air is escaping too rapidly from the shelter. An inspection of the gas-tight doors should first be made; then, if they are found to be correctly closed, the louvre valves and over-pressure valves should be attended to in turn to restore the pressure to the correct figure. A simultaneous fall in the gauge pressure and aerometer reading indicates a rise in the inlet resistance, due either to the clogging of the dust filter or of the gas filter. If the trouble lies in the former, a rise of both readings will follow its removal. The dust filter may be cleaned by washing in petrol or carbon tetrachloride, and it should afterwards be smeared with thin oil. If the removal of the dust filter, which it is advisable to carry out when wearing a respirator and anti-gas gloves, does not restore the readings, the inference is that the gas filter is choked and must be replaced by a spare. The exposed pipe ends are rendered tight by closing both the shut-off valves. The open ends of the "spent" filter can be blanked off by flanges. The setting of the various valves in the case of a gas attack is generally the same as that described for ordinary ventilation, except that the yellow shut-off valve should be closed and the red shut-off valve opened.

The Andamite system is easy to operate and to maintain and should be effective in keeping a shelter habitable in the case of a gas attack. It is not possible to state the whereabouts of actual installations, but it may be said that examples have been erected in such situations as large electrical and general engineering works, textile factories, municipal fire stations, gas works, electric power stations, steelworks, railway premises, banks, etc.

THE EXPORTS CREDITS GUARANTEE DEPARTMENT.—During the quarter ended June 30, the Export Credits Guarantee Department assumed liability up to a maximum of 12,881,950*l.*, in respect of contracts, policies and guarantees amounting to 26,343,400*l.*

THE HAGUE TIN STATISTICAL OFFICE.—It appears that circulars have recently been posted from Holland to the United States and elsewhere, bearing the inscription "International Tin Research and Development Council—Statistical Office." It is stated in the journal *Tin* that the Council's Statistical Office at The Hague was closed following the German invasion. Since that time there has been no contact or communication of any kind between the Council and the organisation at The Hague, which, it must be assumed, is under German control and no longer in a position to issue reliable information. It is further emphasised that the organisation at The Hague, which issues such circulars, is now entirely separated from the tin-producing interests in the allied countries, including the Netherlands East Indies.

THE SPERRY SYSTEM OF RAIL-DEFECT TESTING.

THE account in ENGINEERING, vol. 150, page 223 (1940), of the Sperry rail-defect testing car may now be supplemented by a short account of some further developments in the defect-detecting devices. The earlier equipment, though it operated successfully within its range, was not equally responsive to all the kinds of defects which may exist in a rail. The variety and importance of these defects will be obvious from a study of the article referred to above. A limitation of the original car was that the record of what is known as a wheel burn was generally interpreted to be a surface defect, so that the operator usually considered it to be unnecessary to stop the car and examine the defect more closely with the hand equipment. But more careful examination would have shown, in the majority of instances, that there was a serious fracture lying beneath the burn, this defect being due to the deterioration of the rail from a braked wheel sliding on the surface or from wheels slipping on the rails when starting. Unlike fracture cracks, which may be almost invisible on the surface, the wheel burn, as a rule, is clearly apparent. As just stated, however, visual inspection does not give any indication of what may be underneath and it is for this purpose that the detecting devices have been augmented.

In the new device there are now three indicating pens for each rail. The first pen of this equipment approximates in function to the pen of the original equipment in that it is particularly responsive to transverse internal fractures and will record such fractures if they extend over as little as 10 per cent. of the rail cross section. This pen is also sensitive to surface defects. The second pen supplements the first pen since it is more responsive to flux changes produced by compound fissures and similar defects. It is less sensitive to common surface defects than the first pen. The third pen supplements the other two and is designed particularly for the detection of internal defects under wheel burns. It is relatively insensitive to surface defects. Both the second and third pens are actuated by mechanism which is distinct from that actuating the first pen. What is now traced on the recording chart are eight graphs, four for each rail, viz., three for the three defect-detecting pens and one for an indication of the current flow, this last trace being virtually a straight line. If, then, the operator examines the chart as it is traversed, the first pen graph may show a number of interruptions indicating both internal defects and wheel burns; the second pen graph may or may not also register the burns as well as internal defects; and the third pen graphs show internal defects under wheel burns.

If the interruptions of the first pen are not duplicated on the graph of the second pen, or are only faintly indicated, there is no need to stop the train at these points to examine the rail by the hand-testing instrument referred to in our first account, but, if the burn is recorded on all three graphs simultaneously, the indication is that an internal defect is present below the burn and it is imperative to stop the car and to examine the region of the burn by the hand instrument in order to get a quantitative reading of the area of the rail section affected. It should be noted that a fracture under a wheel burn may be a progressive development from serious thermal cracks on the rail surface in a manner analogous to the growth of fissure cracks from other causes. Variation in the nature of wheel burns may be directly related to the type and size of locomotives employed in the normal traffic of the railway. It is possible also that bending of the rail under load may accelerate development of wheel burn fractures, particularly as the fracture starts immediately below the running surface when the stress per unit area is high. The bending can be influenced to some extent by the nature of the ballast employed. However, no precise reasons for the trouble can yet be given as the variation in different railways is considerable. At the same time, the new rail-defect detecting equipment should expedite the eventual solution of the problem. The developments are, of course, due to the original designers of the method, viz., Messrs. Sperry Products Incorporated, Hoboken, New Jersey, U.S.A.

LICENCE FOR D.B.L. HIGH-SPEED STEEL.—It is stated in a recent issue of *The Iron Age* that in order to conserve supplies of tungsten and to assist in the manufacture of munitions, the Allegheny Ludlum Steel Corporation, Pittsburgh, U.S.A., has offered to grant a licence for the manufacture, free of royalty, of its D.B.L. high-speed steel. A typical percentage composition of this steel is given as: carbon, 0·80; tungsten, 5·25; chromium, 4·00; vanadium, 1·50; and molybdenum, 4·00. It is claimed to possess cutting properties equal to, or better than, those of ordinary 18-4-1 tungsten-chromium-vanadium steel.

INSTITUTION ELECTIONS.

INSTITUTION OF ELECTRICAL ENGINEERS.

Associate Member to Member.—William Thomas J. Atkins, B.Sc. (Eng.), Leeds; Herbert Blades, Birmingham; Edward Priestley Burdett, M.A., London, N.W.11; Horace Cardwell Day, Heywood, Lancs.; James Gogan, Glasgow; John Humphrey R. Nixon, Loughborough; Douglas Charles Thomson, B.Sc., London, S.W.15.

Associate to Member.—Arthur Howell, Newcastle-upon-Tyne.

Associate Member.—Harry Bamford, Derby; John Ernest Barrett, Milford Haven; James William Buckley, M.Sc., Gerrards Cross, Bucks.; Ralph Henry Campin, London, S.E.9; Benjamin Harry Caswell, Wolverhampton; Alfred George Cutts, Chester; James Albert Darbyshire, M.Sc., Ph.D., Manchester; Thomas Gabriel Dash, Bargoed, Glam.; Major William James Davis, R.A.O.C., Brockworth, near Gloucester; Edward Arthur T. Fletcher, Glasgow; Aubrey Fulford, B.Sc. Tech., Manchester; John Henry O. Harries, London, S.W.4; James Johnstone, Evanton, Ross-shire; John Massey Morris, Basrah, Iraq; Eric Robertson, London, N.W.11; Edward Tyler, D.Sc., M.Sc., Ilford, Essex; Captain Keith Charles H. Warren, R.A.S.C., Blackdown, Hants.

BRITISH STANDARD SPECIFICATIONS.

THE following specifications of engineering interest have been issued by the British Standards Institution. Copies are obtainable from the Publications Department of the Institution, 28, Victoria-street, London, S.W.1, and, unless otherwise stated, the price is 2*s.* net, or 2*s.* 3*d.* including postage.

Spectacle-Type Goggles.—A new specification for spectacle-type goggles for protection against flying particles (No. 955-1941) has now been issued. Its preparation was authorised by the Personal-Safety Equipment Industry Committee at the request of the Gas Industry Committee after a conference of the principal interests concerned had considered the question. Eye hazards are generally recognised as the most serious of all non-fatal industrial risks, and the need for adequate eye protection is therefore obvious. The goggles specified are those which, after exhaustive practical tests, are considered to be the most satisfactory for the purpose. It is realised that the wearing of goggles is resented by many workers, owing to the discomfort caused by unsatisfactory types. Hence, special attention has been paid to the comfort of the various types recommended. It should be remembered, however, that adequate protection must be the first consideration. The specification deals with the quality and preparation of the material of the lenses, and of the frames and with various tests for determining the mechanical strength of the frames, lenses, joints, etc.

Intensities of Lighthouse Beams.—Recently-issued specification, No. 942-1941, relates to British Standard formulæ for calculating the intensities of lighthouse beams and beams from cognate projection apparatus. This matter has been brought forward for discussion at meetings of successive international technical conferences on lighthouses and sea marks without any conclusive results having been obtained. On account of the various formulæ used hitherto in different countries for the computation of these intensities, the values published in the Light Lists had little real significance, as they were not truly comparable. It was felt desirable that there should be a common basis for calculation from which all authorities could work. As a result of a conference of those interested in the subject, held in this country, a committee was set up by the British Standards Institution under the Illumination Industry Committee. As a commencement, a memorandum was prepared bringing together in one publication, all the available information which previously had been spread over many papers and treatises, some of which are still unpublished. It was then agreed, in the first instance, to proceed from the national side and endeavour to obtain agreement on a national specification, which, however, before final publication, should be circulated for comment to all the countries represented at the International Lighthouse Conference and also to those countries belonging to the International Commission on Illumination. Owing to the intervention of the war, however, it has not been possible to obtain much comment from abroad, but what has been received has been entirely favourable. In addition to definitions of terms, specification No. 942-1941 deals with such matters as types of beam-projection apparatus and of light beams, light sources, coloration of beams, intensity of stationary and rhythmic lights and coloured beams, range of light, and colour filters. [Price 3*s.* 6*d.* net, or 3*s.* 9*d.* including postage.]

PERSONAL.

We are informed that DR. H. L. GUY, F.R.S., M.Inst.C.E., M.I.Mech.E., resigned his office of Chief Engineer of the Mechanical Department of Messrs. Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester 17, and also his directorship of Messrs. Metropolitan-Vickers Export Company, Limited.

MR. ASHLEY S. WARD has been appointed chairman and managing director of Messrs. Thos. W. Ward, Limited, Albion Works, Savile-street, Sheffield, and chairman of The Ketton Portland Cement Company, Limited. MR. GEORGE WOOD has been appointed deputy chairman and joint managing director, and MR. ARNOLD CARR a full director of Messrs. Thos. W. Ward. MR. F. R. STAGG, who is assistant managing director of Messrs. Thos. W. Ward, has been appointed deputy chairman and managing director of The Ketton Portland Cement Company.

MR. W. J. PRICE, M.Inst.C.E., deputy director of Public Works, Ceylon, has been appointed director. MR. O. T. NETTLETON, M.Inst.C.E., senior superintending engineer, has succeeded Mr. Price as deputy director.

MR. G. I. GORING, A.M.I.Mech.E., has been promoted from the position of chief mechanical engineer to that of general manager, Transport and Harbours Department, British Guiana. MR. A. H. JULY, who was previously assistant mechanical engineer, has been promoted to succeed Mr. Goring as chief mechanical engineer.

MR. W. H. MCLUCKIE, M.Inst.C.E., assistant director of Public Works, Tanganyika Territory, has been made director of Public works, Northern Rhodesia.

THE CARBORUNDUM COMPANY, LIMITED, Trafford Park, Manchester, 17, inform us that the address of their London office is now 3 and 4, Parkfield Parade, High-road, Ickenham, Middlesex (Telephone Ruislip 3586).

MR. H. GARLICK has been elected chairman of the Lancashire and Cheshire branch of the Institution of Structural Engineers for the session 1941–42. Other recent elections include that of MR. A. G. THOMPSON, B.Sc., as the new chairman of the South Wales and Monmouthshire branch, and that of PROFESSOR J. F. BAKER, M.A., D.Sc., as the new chairman of the Western Counties branch.

The Board of Trade has appointed MR. J. R. C. HELMORE to be Principal Assistant Secretary and Principal Establishment Officer (a new post). MR. H. TOUT has been appointed temporary assistant secretary, Industrial Supplies Department in succession to Mr. Helmore.

MR. J. S. PECK, who has been chief electrical engineer of Messrs. Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester, 17, for 37 years, has retired from this position while still retaining his seat on the board. MR. G. A. JUHLIN has succeeded Mr. Peck in the position of chief electrical engineer.

MR. R. F. MOSKILL, who is joint signal engineer of the London Passenger Transport Board, has been elected vice-president of the Institution of Railway Signal Engineers.

PROFESSOR C. O. BANNISTER, M.Eng., A.R.S.M., F.I.C., is retiring from the Chair of Metallurgy at the University of Liverpool, which he has occupied since its foundation in 1920.

MR. ALEXANDER DUNBAR, who is a director of Messrs. English Steel Corporation, Limited, Vickers Works, Sheffield, 9, has been appointed Director-General of Materials Production, Ministry of Aircraft Production.

MESSRS. SMALL AND PARKES, LIMITED, Hendham Vale Works, Manchester, 9, have transferred their London office to 18, High-street, Wimbledon, S.W.19 (Telephone WIMbledon 4248–9).

At the invitation of the President of the Board of Trade, the HON. GEOFFREY CUNLIFFE has joined the Industrial and Export Council as a business member. He relinquishes his position as Aluminium Controller to the Ministry of Aircraft Production, but will still be available for consultation.

CAPTAIN J. B. BLACK, managing director of Messrs. Standard Motors Company, Limited, has been appointed chairman of the Joint Aero-Engine Shadow Committee of the Ministry of Aircraft Production in succession to MR. W. E. ROOTES.

DR. A. H. RAILING and MR. LESLIE GAMAGE have been made general managers of Messrs. The General Electric Company, Limited, Magnet House, Kingsway, London, W.C.2. They have both been directors for many years.

QUOTAS ON IMPORTS OF ELECTRIC LAMPS INTO EIRE.—The United Kingdom Trade Commissioner at Dublin has forwarded to the Board of Trade a copy of the Control of Imports (Quota No. 34, Eleventh Period) Order, 1941. This appoints the period August 1, 1941, to July 31, 1942, as the eleventh period under the Order relating to the importation into Eire of certain electric filament lamps, and fixes the quota for that period at 100,000 articles.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Iron and Steel.—Many Sheffield firms will shut down for a week's holiday during August Bank Holiday week when urgent repairs will be carried out to furnaces and machines which have been running at their maximum capacity since Whitsuntide. Improving business is being done in basic billets and acid steel, and bar-iron makers are producing larger outputs. The scrap market is strong, and heavy tonnages of all types of scrap steels are changing hands. Foundries, forges, press shops, rolling mills, and wire and rod mills are all operating at increased capacity as compared with a year ago; re-rollers are particularly busy. Activity is of a uniform character in the heavy-machinery and engineering branches. Works supplying all descriptions of steel-works and ironworks' machinery and equipment are busily employed, and are executing a record number of orders. Among the lines in demand are rolling mills, hydraulic presses, forging plant, bending machines, automatic shears, planers, and various types of electric furnaces; gas-fired furnaces are also in strong demand. In addition, machinery for crushing, milling, cement mixing, precious-metal mining, roadmaking and quarrying are in request. More orders are being received for electrical plant, and large hollow forged boiler drums are required for power-station extensions. There is great activity in the special-steel producing branches. Special steels are in increasing demand for various purposes, particularly in connection with the production of refrigerating machinery, superheated-steam valves, ball races, pump rods and plungers, gear pumps, turbine blades, shafts, etc. Agricultural-machinery engineers in all parts of the country are taking larger quantities of high-grade steels. Engineers' small tools are also active.

South Yorkshire Coal Trade.—Collieries in this area are dispatching large tonnages of coal than for several months past. Industrial coal is moving freely, and steams, slacks and smalls are in strong demand. Locomotive coal is more active. The house coal market is developing on more favourable lines, as merchants in the South of England are placing orders more freely. Foundry and furnace coke are steady, and blast-furnace coke is a progressive medium.

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Welsh Coal Trade.—The views of the South Wales miners on matters relating to the future of the industry played a prominent part in the recent conference of the Mineworkers' Federation of Great Britain held in Scotland. A resolution put forward by the executive and seconded by Mr. Arthur Horner, president of the South Wales Federation, contained a number of suggestions made by the local Federation. This advocated the establishment of a national board to cover the mining industry to be composed of an equal number of representatives of the Mining Association and the Mineworkers' Federation. The Board, so it was suggested, would have power to consider and decide, either by agreement, or in the event of failure to agree, by recourse to an independent chairman or board of arbitrators, all matters which directly or indirectly affected the wages, conditions and safety of the miners. It was also proposed that the Board should fix a national wage for all workers in and around the mines. Considerable interest has again been displayed on the Welsh steam-coal market by buyers in both the home and foreign sections. In both directions, however, the amount of new business that could be negotiated, either for early or forward delivery, was severely curtailed by the heavy commitments of most producers. Best large coals were only quietly available for delivery for some time to come and the sized sorts were sparingly offered. The bituminous small descriptions continued to provide the strongest section of the market, and, with potential outputs well sold ahead, the tone was strong. Bituminous smalls were plentiful to meet a slow request and were consequently dull. Cokes and patent fuel were quiet.

The Iron and Steel Trade.—The tin-plate market remained quiet, but all other sections of the iron and steel and allied trades of South Wales and Monmouthshire continued to display a good activity during the past week. The demand was keen but supplies were difficult to secure for delivery for some time ahead.

SWANSEA STEEL-SHEET MARKET.—The current market report of the Incorporated Swansea Exchange, Royal Metal Exchange, Swansea, states that there has been no relaxation in the restrictions imposed on the tin-plate market, which remains quiet as far as ordinary commercial business is concerned. On the other hand, galvanised and other steel sheets are not quite so active and makers are now willing to book further orders. The strong demand for iron and steel scrap shows no abatement.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

General Situation.—The deliveries of iron and steel to licensed consumers, although sufficient for the requirements of the war industries, do not yet justify a material increase in the allocation of tonnage for general industrial undertakings. Producers of several commodities are now abreast of their contract obligations and in a position to book orders for the reasonably early delivery of material for essential current needs. The reduced needs for the import of products from overseas has found some shipping space for other purposes.

Cleveland Iron Trade.—Exceptionally large quantities of scrap are passing into use, but increasing activity at the foundries necessitates an appreciably enlarged consumption of pig iron. There is no lack of pig, though Cleveland qualities are scarce. Deliveries of Midland brands to North-East Coast foundries are quite satisfactory and adequate parcels of certain qualities of iron for specified purposes continue to arrive from other sources. Transactions are mostly direct between producer and consumer, but business through second hands is on a somewhat increased scale. The official quotations for Cleveland pig are ruled by No. 3 description at 128*s.* delivered within the Tees-side zone.

Basic Iron.—The production of basic iron is maintained at a level that covers the requirements of the makers' own steelworks, but leaves no surplus for the market and, in the continued absence of sales, the recognised value remains nominal at 120*s.* 6*d.*

Hematite.—Conditions in the hematite branch of the trade still necessitate a restriction of the tonnage distribution, but the position is being gradually eased by the increased use of substitute iron. Rationing of consumers, however, is still unavoidable and adherence to the control of distribution regulations is likely to be necessary for some time. Stabilised prices are at the equivalent of No. 1 grade of hematite at 138*s.* 6*d.* delivered to North of England areas.

Blast-Furnace Coke.—The local consumption of Durham blast-furnace coke is heavy but users are well covered and are not inclined to make further purchases. Sellers have a substantial tonnage for disposal but are anxious to reduce their delivery obligations before entering into further commitments. Fixed prices are based on good medium qualities at 36*s.* 9*d.*

Manufactured Iron and Steel.—Users of semi-finished iron and steel have considerable stocks and are receiving steady deliveries of home-made semies. Makers of finished iron have well-filled order books and steel producers have sufficient work in hand to ensure the full activity of plant for some time ahead. Reduced outputs of sheets and structural material are reported, but the production of other commodities remains on an exceptionally large scale. Priority attention is still given to specifications for shipbuilding requisites.

Scrap.—Heavy deliveries of iron and steel scrap are reaching the consuming plants. Light material is in ample supply, but the machinery metal, heavy cast iron and heavy steel scrap available is barely sufficient to cover the exceptionally large requirements of users.

BRICK INDUSTRY COMMITTEE.—The Minister of Works and Buildings, in view of the importance of an efficient brick industry, both during and after the war, has decided, with the agreement of the industry, to appoint a committee, representative of all interests, to advise him on the subject. Mr. Oliver Simmonds, M.P., has agreed to be chairman of the Committee, which will, in particular, advise on steps to be taken to secure adequate output, maximum co-ordination, the pooling of resources and information, economy of manufacture and the introduction of more scientific methods. The Committee will first consider the steps to be taken immediately to assist the war effort.

SCHOLARSHIPS IN ELECTRICAL ENGINEERING.—The Council of the Institution of Electrical Engineers has awarded the Duddell Scholarship for 1941 to Mr. J. C. Cain, of Emmanuel School, London; the Silvanus Thompson Scholarship to Mr. R. C. Langford, of H.M. Dockyard, Portsmouth; the William Beedie Esson Scholarship to Mr. E. Bailey, of Messrs. Metropolitan-Vickers Electrical Company, Limited, Manchester; the David Hughes Scholarship to Mr. W. Davies, of University College, Cardiff; the Salomons Scholarship to Mr. C. G. Cheshire, of the Heriot-Watt College, Edinburgh; the Paul Scholarship to Mr. R. Pocock, of the L.C.C. School of Engineering and Navigation, London; and the Thorrowgood Scholarship to Mr. R. G. Bates, of the London Midland and Scottish Railway Company. As was the case in 1940, no awards of the Ferranti or Swan Memorial Scholarships, or of grants from the War-Thanksgiving Education and Research Fund, have been made this year.

NOTICES OF MEETINGS.

IT is requested that particulars for insertion in this column shall reach the Editor not later than Tuesday morning in the week preceding the date of the meeting.

PHYSICAL SOCIETY.—To-day, The Science Museum, Exhibition-road, South Kensington, S.W.7. 4.40 p.m., Annual General Meeting. (i) Presentation of the Report of the Council. (ii) Election of Officers and Council for 1941-42. 5 p.m., Science Meeting. The First Charles Chree Address on "(i) Chree and His Work on Geomagnetism; (ii) Geomagnetic Time Relationships; (iii) The Future of World Magnetic Surveying," by Professor Sydney Chapman.

IRON AND STEEL INSTITUTE.—Saturday, July 26, 6.15 p.m., The Newport Technical College, Newport, Mon. Joint Meeting with THE NEWPORT AND DISTRICT METALLURGICAL SOCIETY. Lecture by Dr. C. A. Edwards, based on paper entitled "The Influence of Some Special Elements Upon the Strain-Ageing and Yield-Point Characteristics of Low-Carbon Steels," by Dr. C. A. Edwards, Mr. D. L. Phillips and Mr. H. N. Jones.

SOCIETY OF GLASS TECHNOLOGY.—Wednesday, July 30, 10.30 a.m., The School of Art and Crafts, Stourbridge. Ordinary General Meeting. (i) "Experimental Procedure Desirable in the Preparation of Modified Commercial Lead-Oxide Glasses," by Dr. J. H. Partridge. (ii) "Note on the Rate of Rise of Internal Temperature During the Firing of Refractory Blocks," by Dr. Eric Preston and Professor W. E. S. Turner. (To be followed by a luncheon at the Talbot Hotel, Stourbridge, at 12.30 p.m.)

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scottish Steel Trade.—In the Scottish steel trade production has been so well maintained during recent months that supplies to the works making munitions, and others working on Government contracts, has been ample for all requirements. The steelworks closed down at the end of last week for a ten-days' holiday. The stoppage has been found necessary this year owing to the fact that plant generally requires an extensive overhaul. The demand for material continues, especially for special qualities of steel for the aircraft industry. In the black steel-sheet trade a slightly quieter tone has again to be noted, but there are still many important contracts on the books. The following are the current prices:—Boiler plates, 17*l.* 12*s.* 6*d.* per ton; ship plates, 16*l.* 3*s.* per ton; sections, 15*l.* 8*s.* per ton; medium plates, ¼ in. and thicker, rolled in sheet mills, 21*l.* 15*s.* per ton; black steel-sheets, No. 24 gauge, 22*l.* 15*s.* per ton; and galvanised corrugated sheets, No. 24 gauge, 26*l.* 2*s.* 6*d.* per ton, all for home delivery.

Malleable-Iron Trade.—Conditions in the malleable-iron trade of the West of Scotland have varied little during the week. A fair amount of business is on hand, and the stocks of raw materials are satisfactory. No change has taken place in the state of the re-rolling industry, and although order books are still well filled more work could be undertaken. Good supplies of semies are held. Quotations are as follows:—Crown bars, 15*l.* 12*s.* 6*d.* per ton; No. 3 bars, 13*l.* 12*s.* 6*d.* per ton; No. 4 bars, 13*l.* 17*s.* 6*d.* per ton; and re-rolled steel bars, 17*l.* 15*s.* per ton, all for home delivery.

Scottish Pig-Iron Trade.—Activity is general in the Scottish pig-iron trade and the output continues on a large scale. All the furnaces are in blast this week, and as the steelworks are not functioning for ten days a good tonnage of hematite and basic iron should be accumulated for the restart after the holidays. Prices are unchanged and the following are to-day's market quotations:—Hematite, 6*l.* 18*s.* 6*d.* per ton; and basic iron, 6*l.* 0*s.* 6*d.* per ton, both delivered at the steel works; foundry iron, No. 1, 6*l.* 5*s.* 6*d.* per ton, and No. 3, 6*l.* 3*s.* per ton, both on trucks at makers' yards.

Raw Materials.—Good supplies of raw materials have been arriving in this country during the past year and ample stocks are available for all purposes. These are stored over a wide area and can be drawn on when required.

WORLD CRUDE-OIL PRODUCTION.—Figures published in *World Petroleum* show that, in 1940, the United States produced 1,352 million barrels of mineral oil, an increase of 6·83 per cent. over the 1939 total and equivalent to 63 per cent. of the world's production. Countries other than the United States produced 794 million barrels in 1940, or 2·11 per cent. less than in 1939. There were, however, increases in production, as compared with 1939, in the U.S.S.R., Colombia, Argentina, Canada, Trinidad, and Egypt.

THE "MATILDA" INFANTRY TANK.

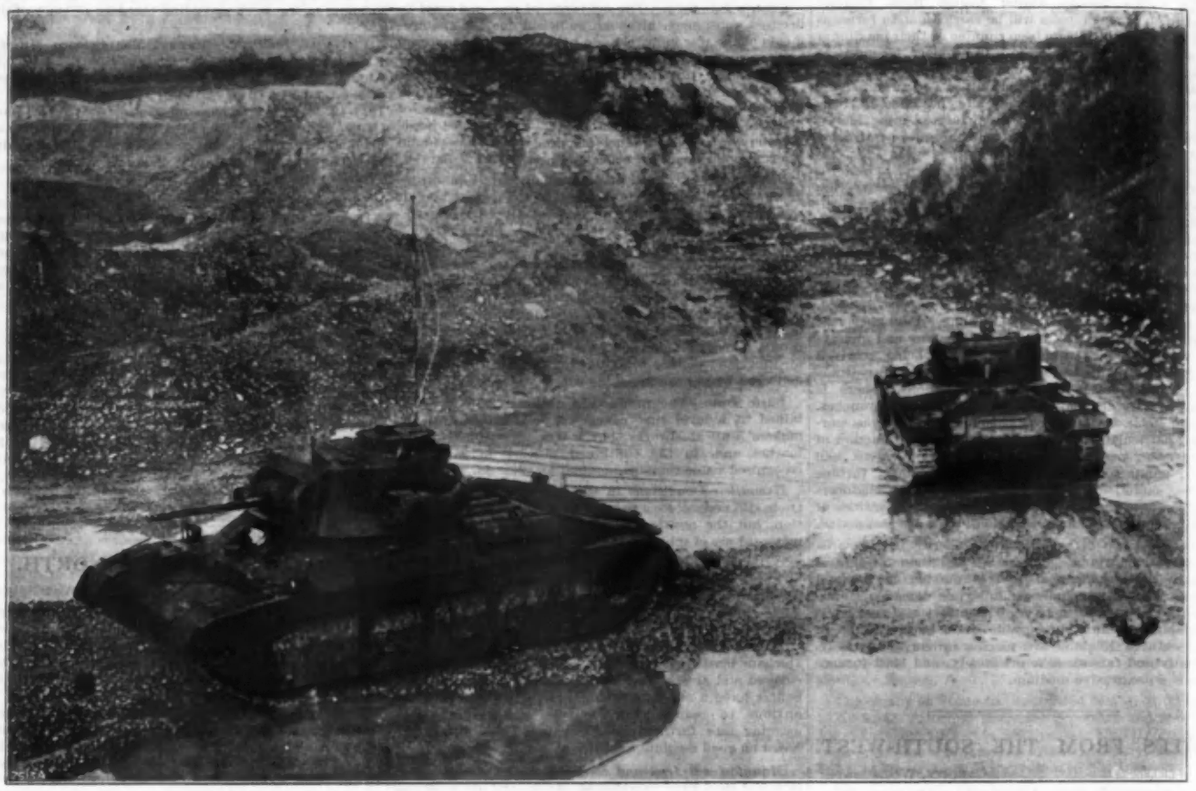


FIG. 1.

THE "MATILDA" INFANTRY TANK.

IN last week's issue of ENGINEERING, we reproduced a number of official photographs of the new "Valentine" type of infantry tank, together with two illustrations of one of the types used by the Russian forces. We are now able to supplement these with the accompanying photographs, Figs. 1 and 2, showing a British "Matilda" tank, with a Valentine tank in the background. The Matilda is considerably heavier than the Valentine, weighing about 26 tons, and is easily identified by the armour "skirt" which protects the tracks and supporting wheels. It will be seen, by comparing Fig. 2 with the views of the Valentine, published last week, that these wheels are considerably more numerous in the Matilda, and are of smaller diameter, to support the greater load. The turret is generally similar to that of the Valentine, but has a small cupola on top. Matilda tanks have been actively engaged from time to time in Libya and the Western Desert, where it is understood that the value of the armour side-shields and the general excellence of the design have been conclusively proved. A recent announcement disclosed that another new design of tank, known as the "Churchill," is now in production, but no particulars of this type have yet been released for publication.

FIG. 2.

WORLD PRODUCTION OF TIN.—It is stated in a recent issue of the *Statistical Bulletin* of the Tin Research Institute that the world production of tin in May, 1941, was estimated to be 22,200 tons, compared with 17,100 tons in April. The production for the first five months of 1941 was 96,000 tons, against 85,400 tons in the corresponding period of 1940.

THE CLEANING OF BLAST-FURNACE STOVES BY FLUSHING.—Writing in a recent issue of the American journal *Blast Furnace and Steel Plant*, Mr. E. Steinbacher describes a method of removing the dust deposited in the chequer-work of blast-furnace stoves by means of water jets. The stove to be cleaned is isolated from the gas system and allowed to cool sufficiently to enable men to work in it. A water-supply line is passed through a manhole in the top of the stove and a manifold having four flexible tubes, furnished with special jets, is connected to it in the space above the chequers. The jets are passed down each vertical passage in turn. A 6-in. hole is cut in the steel plate at the bottom of the stove for draining off the water and sludge. It is stated that, if the chequer-work is fairly cool at the beginning of the operation and thoroughly dried afterwards, the refractories are not adversely affected; neither is the life of the stove shortened. The time required for complete flushing, employing three men, is about 16 hours to 20 hours.

ENGINEERING.

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TIME FOR RECEIPT OF ADVERTISEMENTS.

Classified advertisements intended for insertion in the current week's issue must be delivered not later than first post on Wednesday. Alterations to standing advertisements must be received at least 10 days previous to the day of publication. Passed proofs must be in our hands by Saturday morning, otherwise they will be taken as correct. The Proprietors will not hold themselves responsible for blocks left in their possession for more than two years.

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ENGINEERING

FRIDAY, JULY 25, 1941.

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THE UTHWATT REPORT.

THE publication, on July 17, of the Interim Report of Mr. Justice Uthwatt's Expert Committee on Compensation and Betterment, and the debate upon it in the House of Lords later on the same day, may be regarded as marking the first stage in the vast programme of reconstruction which must be the primary consideration as soon as active hostilities cease. It would be more correct, perhaps, to say that it is the reconstruction, and not the programme, which should be the first care and occupation after the war; for there is almost universal agreement that the programme should then be in an advanced state of definite planning, so that immediate steps can be taken to put it into operation as soon as the way is clear to divert the national energy of war production to other and more peaceful channels. The details must await calmer times than the present, but the broad outline of what is to be done must be sketched without delay, in order that the legislative and other needs may be appreciated at the outset and proper measures concerted to meet them. That Lord Reith, on his appointment as Minister of Works and Buildings, fully realised the urgency of this task, was evident from his statement in the House of Lords on February 26, and from his speech at the luncheon of the Institution of Civil Engineers, which we reported briefly on page 373 of the previous volume of ENGINEERING. One of his first acts was to set up the committee with which Mr. Justice Uthwatt's name is associated, and it is evident from their Interim Report* that the committee, also, fully understood the urgent nature of their inquiry.

The Uthwatt Committee consists of Mr. Justice Uthwatt (chairman); Mr. James Barr, vice-president of the Chartered Surveyors' Institution; Mr. Gerald Eve, a past-president of the same institution; and Mr. F. R. Evershed, K.C., with Mr. H. F. Williams, of the Board of Trade, as secretary. Mr. James Wylie, C.B.E., barrister-at-law, was also appointed to serve on the committee, but was unable to attend any meetings on account of ill-health; he died early in February, without having taken any part in the preparation of the report. The terms of reference were "To make an objective analysis of the subject of the payment of compensation and recovery of betterment in respect of public control of the use of land; and to advise, as a matter of urgency, what steps should be taken now or before the end of the war to prevent the work of reconstruction thereafter being prejudiced." In this connection, the Committee were asked to consider (*a*) possible means of stabilising the value of land required for development or redevelopment, and (*b*), any extension or modification of powers to enable such land to be acquired by the public on an equitable basis; to examine the methods proposed, and to advise what alterations of the existing law would be needed to give effect to them. In the Interim Report, however, they considered only the initial problem, namely, "what steps should be taken now or before the end of the war to prevent the work of reconstruction thereafter being prejudiced."

In arriving at their conclusions, the Committee state, they were guided by Lord Reith's statement, on February 26, that he was authorised to proceed with the preliminary work on the assumptions (1) that the principle of planning would be accepted as national policy and that some central planning authority would be required; (2) that this authority would proceed on a positive policy for such matters as agriculture, industrial development and transport; and (3) that some services would require treatment on a national basis, some regionally and some locally. The Committee accepted these postulates, and endorsed the view that a central planning authority was essential to an effective physical reconstruction after the war; and that it must be set up at an early date, in order to proceed at once to take the necessary preliminary steps.

Briefly, the main recommendations of the committee were as follows. They advised that the Government should announce at once, as a general principle, that compensation for the public acquisition or control of land will not exceed its value at March 31, 1939—this being the date adopted for measuring compensation under the War Damage Act, 1941. As soon as possible, areas which may be the subjects of reconstruction planning schemes should be defined, so that the persons affected may learn where they stand, and that such areas should be prescribed, without waiting for the end of hostilities, on the assumption that they may be redeveloped, without necessarily determining immediately that they will be; but that, where the local authority is the prescribing authority its decisions should be subject to review by the central planning authority is the prescribing authority, its decisions be aggrieved by the decision. In the legislation setting up the central planning authority, provision should be made to invest that authority with power to control building and all other developments throughout the country by reference to national planning considerations. Licences to build, in any prescribed area, should state clearly whether, in the event of a development programme being subsequently undertaken in that area, the structures erected are to rank for compensation if it should prove necessary to remove them. No definite recommendation was made regarding undeveloped land, except that, pending decisions of policy, the controls in force should be continued, together with such powers as are now exercisable under Defence Regulations by the Minister of Agriculture and the Secretary of State for Scotland.

Lord Reith, in stating the Government's policy, said that they accepted the Committee's recommendation regarding the basis of compensation, and agreed also that the reconstruction areas should be planned as a whole and that planning authorities should have power to acquire land compulsorily, subject to the safeguards stated. Legislation to that effect would be introduced as soon as war conditions permitted. It was considered that the further safeguards necessary to control building could be provided by strengthening the existing Planning Acts. To ensure that current administration of planning statutes, in town and country, would conform with the development of long-term plans, arrangements had been made for the Minister

* Cmd. 6291 London: H.M. Stationery Office. [Price 3*d.* net.]

of Works and Buildings to retain special responsibility for this long-term policy, and a Council of Ministers was appointed to co-ordinate this work. The Council would consist of himself, as chairman, together with the Minister of Health and the Secretary of State for Scotland. Their terms of reference would be: "To ensure that the administration of the Town and Country Planning Acts and of any legislation implementing the recommendations made in the First Report of the Uthwatt Committee shall proceed in conformity with long-term planning policy, as it is progressively developed." The Council of Ministers was to be regarded as the desired Central Planning Authority in embryo, but it might develop eventually into a Ministry of Planning. Meanwhile, the preliminary steps in the preparation of a national plan would be pressed forward as rapidly as possible.

The Government's decisions were subjected to a certain amount of criticism in the House of Lords, mainly on the ground that they did not go far enough; but, in general, they must be regarded as having established a workable basis on which to proceed. In view of the frequent complaints that engineers as a class are not sufficiently concerned with legislative affairs, it must be considered satisfactory that the new Council of Ministers is to be presided over by a forceful administrator who is an engineer by training and, as his public pronouncements have shown, possesses in a marked degree the faculty of grasping the essentials of any problem with which he may be confronted. Certainly, those which will confront him in his present task are likely to be both numerous and complex, and will not be less difficult to tackle by reason of the many purely engineering considerations that are bound to arise as the details of the national plan are developed. Questions of power supply and distribution, the improvement of transport facilities and the handling of goods, and the zoning of industrial, commercial and agricultural operations, to mention only a few of the main heads, are affected by much more than purely aesthetic considerations. The establishment of a proper economic balance between the essential and the desirable will involve also a closely detailed consideration of the interaction of the various sectional reconstruction programmes, if the march of development is not to suffer local delays.

The problem is further complicated by the fact that it is not only the physical reconstruction of towns and cities and industrial districts generally that must be undertaken: the reconstruction of the whole structure of British trade must be undertaken simultaneously, and to this a large part of the productive capacity of the country will have to be diverted at the earliest possible moment. It has been urged repeatedly that plans for reconstruction must be based on something wider than a merely parochial outlook; but it is possible to retain a parochial outlook even on a national scale, and to allow the claims that are nearest to assume a somewhat exaggerated significance. This is a tendency to which, perhaps, local authorities are more liable than national authorities; and it is probable that one of the most difficult tasks which await the Central Planning Authority, when it is finally constituted, will be that of persuading such local bodies that the prime essential in reconstruction is not the provision of social amenities, but the re-establishment of industry on a sound basis, so that the lost markets can be regained, new markets developed, and a steady income assured with which to pay the colossal cost of implementing the reconstruction plans. It is to be hoped, therefore, that the Council of Ministers will not confine their attention to the legal, sociological and æsthetic aspects of their task, but will apply themselves also to ensuring that the industrialist is not hampered in the more limited field of reconstructing his war-damaged business and goodwill, either by lack of power, of transport facilities or of freedom to set his own affairs in order at the earliest possible moment, by his own efforts and with the minimum of interference. This is another branch of planning which should receive attention well in advance of the end of the war, so that the work of turning over to peace-time production may begin at the earliest possible moment.

POWER DEVELOPMENT IN THE PACIFIC NORTH-WEST.

THE area covered by the four states of Washington, Oregon, Idaho, and Montana, lying in the north-west corner of the United States, is usually designated in that country by the convenient name of the Pacific North-West. This district has, in general, a relatively low rainfall except in the immediate coastal strip which lies to the west of the Cascade Mountains running roughly parallel to the Rockies, which are situated some 500 miles from the sea. An important part of this area has suffered from serious erosion and large tracts of one-time farmed land have passed out of cultivation. A considerable amount of reclamation work has been carried out by the Soil Conservation Service, while the completion of the Grand Coulee Dam has enabled a major irrigation project to be put in hand. As pointed out in our recent articles on the dam,* this project will ultimately permit of the irrigation, by pumping, of 1,200,000 acres of land lying at an average of 650 ft. above the original level of the Columbia River.

The Pacific North-West, although it contains various large towns, such as Seattle, with a population of 360,000, and Portland with one of 300,000, is a relatively undeveloped area from an industrial point of view. The district has a large lumber industry and its main exports are timber and agricultural produce. In a paper entitled "The Future of Power Use in the Pacific North-West," read before the American Society of Mechanical Engineers in September, 1940, Mr. H. V. Carpenter stated that the value added to raw material by manufacture, in the four States concerned, was 75 per cent. of the national average. If, however, forest products were not included, the figure dropped to 35 per cent., showing the undeveloped state of general manufacture. That this position is unsatisfactory from the point of view of the welfare and progress of the country as a whole, is illustrated by the fact that about 40 per cent. of the undeveloped water power in the United States lies in the area, the configuration of the rivers being such that a much larger percentage than 40 of the total power available in the country could be economically developed.

The Columbia River forms the great potential source of power in the Pacific North-West but, since to develop that power constructional works are necessary of a type rendered possible only by civil engineering developments of comparatively recent date, and as the whole area is relatively inaccessible, it is a matter for no surprise that other works took precedence. The river has formed an important artery of communication since the earliest settlement of the country, but since, as pointed out in our recent articles on the Bonneville Dam,† it is only the lower reaches which are navigable, it was the lower section, and particularly the tidal reach 104 miles long, which contributed to the early development of the hinterland. It was only after the construction of the Northern Pacific Railroad in 1880, that the main part of the area began to be opened up.

The development which has been inaugurated by the construction of the Bonneville and Grand Coulee Dams had its inception in the great series of surveys carried out by the Corps of Engineers of the United States Army from the year 1927 onwards. The purpose of the surveys was the formulation of plans for the improvement of the more important navigable rivers in the country from the points of view of navigation, power development, flood control and irrigation. The survey of the Columbia River, which is stated to be by far the largest river in the United States from the point of view of power development, was completed in 1932. The project ultimately envisaged covers the construction of ten dams on the river, of which those at Bonneville and Grand Coulee form the first two. As the total population of the states of Washington, Oregon, Idaho and Montana is under three millions, it will be realised that the scheme will eventually result in a high figure for power per head. The Bonneville plant, when completed, will have a capacity of 483,000 kW, the corresponding figure for Grand Coulee being 1,890,000 kW. Apart from these two plants, of which the first sections are already in operation, the states of Washington and Oregon contain hydro-electric stations aggregating 1,000,000 kW and steam stations with a total capacity of 400,000 kW. In low-water periods, the hydro-electric power available is reduced to about 613,000 kW, and during the last few years the steam stations have been kept in full operation in the low-water season. That the district is not at present over-powered is evident from the recent report of the Federal Power Commission, referred to in our issue of May 30, page 433, which stated that the increased demand for power in the Bonneville-Grand Coulee area in December, 1940, exceeded the estimate made earlier in the year by 53 per cent.

In the business depression which set in in the United States about the year 1930, the domestic load proved the mainstay of many supply companies, increasing by some 80 per cent. in the course of ten years. The reclamation work, which is an essential item in the Grand Coulee scheme, will ultimately provide a large additional demand for farm and domestic purposes. The settlement of the reclaimed land, however, will necessarily be a slow process and cannot bring any important immediate demand for increased power. Also, as Mr. Carpenter points out, the growth of this type of load is controlled by the ability of the average user to purchase power-consuming equipment. The consumer has to spend more per kilowatt of demand than the power company spends in providing the service. These considerations suggest that there is no prospect of the domestic and farm load being able, for very many years, to utilise the whole of the capacity which is being provided.

Although the population situation and the configuration of the country do not encourage the idea that the Pacific North-West may become an important general manufacturing area in the immediate future, the conditions are particularly favourable for the establishment of electro-chemical industries which consume large amounts of power per employee. This forms a justification for the extensive hydro-electric developments which are being undertaken. An example of the trend of affairs is furnished by the recent contract for the supply of 65,000 kW from Bonneville for the new factory of the Aluminium Company of America, at Vancouver, Washington. Aluminium producers in the United States obtain most of their bauxite from Dutch Guiana. In the case of the Vancouver plant, the ore will be refined at Mobile, on the Gulf of Mexico, or East St. Louis, on the Mississippi, and shipped to Vancouver via the Panama Canal. In a paper entitled "Grand Coulee and Electro-Metallurgical Industries," presented at the same meeting as Mr. Carpenter's paper, Mr. A. E. Drucker stated that large deposits of clay, with an alumina content of 30 per cent. to 40 per cent., exist in Washington and Idaho. With the development of economic methods of extraction, these deposits should become of considerable value in the not very distant future.

There are also important possibilities for the development of the magnesium industry. The most valuable magnesite deposits in the United States, with a magnesium content of from 15 per cent. to 28 per cent., lie in the State of Washington. Magnesium may be obtained from magnesite by an arc-furnace process. Mr. Drucker states that the power consumption is 10 kWh per pound of magnesium metal, which is less than the energy consumption for the production of aluminium. He gives the cost as 10 cents per pound of metal, on a basis of 50 tons of metal per 24 hours. Magnesium produced from the salt brines of Michigan at present sells at from 28 cents to 30 cents per pound, and it is clear that there are possibilities of developing a very important industry by utilising the cheap power available from Grand Coulee. Mr. Drucker also foresees the ultimate establishment of electrothermic magnesium, chromium and iron and steel industries in the area, based on the supplies of cheap current which will become increasingly available as the power plants at Bonneville and Grand Coulee are further extended.

* ENGINEERING, vol. 151, pages 361, 401, 441, 481 and 504, (1941).

† *Ibid.*, pages 301 and 341.

NOTES.

LABOUR PROBLEMS IN FILLING FACTORIES.

THE seventeenth report submitted by the Select Committee on National Expenditure during the present Parliamentary session, and the thirty-first since the Committee was originally appointed, is concerned with working conditions in two of the national filling factories. These establishments are of large size and consist of small buildings, widely separated; and, by reason of the nature of the work carried on, they are situated in comparatively rural areas. It was found that absenteeism was causing considerable dislocation of the work and, during the winter months, varied between 15 per cent. and 20 per cent. At that time, two shifts were being worked; when a three-shift system was introduced, absenteeism fell to between 10 per cent. and 12 per cent. Female absenteeism was between 60 per cent. and 90 per cent. higher than that of the male personnel, and, in every case, the morning shift was the worst. Saturday evening and Sunday morning showed the greatest amount of lost time. In a neighbouring engineering works, however, still employing its peace-time staff, who lived nearby, absenteeism was only 0·75 per cent. over a period of four weeks. On investigating the matter, the sub-committee in charge of the inquiry found that the lost time was mainly attributable to four causes; namely, difficulties of transport, absence of adequate accommodation near the factories, the working conditions, and the seven-day week. Many of the employees were obliged to travel long distances, even as much as 30 miles, by transport services that were already taxed by the requirements of the general public. The report recommends that it should be regarded as a primary duty of the Ministry of Supply to provide adequate services. Hostels were provided for a proportion of the personnel, but were quite insufficient to meet the requirements; and, in some cases, they were considered to be too far away from the factory, the size and layout of which obliged some of the employees to walk a mile inside the gates in order to reach their places of work. The scale of charges, too, sometimes compared unfavourably with the cost of lodgings in the locality. The recommendation is made that the provision of more hostels should be expedited; and that the charges should be reduced and their basis somewhat modified. The principal recommendations regarding conditions of work relate to canteens—not all of which were conveniently sited or fitted with cooking apparatus—and the hours of work, which averaged 56 a week, exclusive of the prolonged travelling time. The abolition of Sunday work is strongly urged by the Committee, who express their conviction that this would result in an increase of output. In conclusion, attention is drawn to the methods of selecting superintendents for these large establishments, and the relatively meagre salaries paid to them under the scale laid down by the Treasury, by comparison with the salaries that they would receive in industrial works of comparable size. The recommendation is made that "revision of the scale of such salaries should be the subject of an urgent review."

THE CONTROL OF IRON AND STEEL.

The Ministry of Supply has issued the Control of Iron and Steel (No. 15) Order, 1941. This came into operation on July 17, and revokes all Orders dealing with iron and steel supplies previously in force, namely, Nos. 8, 10, 11, 12 and 13, all of which were issued during 1940. Although the form of the Order has been changed considerably by the incorporation of provisions which were formerly set out in a separate Direction, the general principles laid down are unaltered, with the exception that three important additions have been made. In the first place, all iron products, except pig iron but including iron castings, have been incorporated in the Distribution of Steel Supplies Scheme, with effect as from September 1. For the period up till August 31, however, Direction No. 1, issued with the Order, maintains the present arrangements for the licensing of iron products. Any orders outstanding at August 31 and orders placed after that date must be authorised under the Distribution Scheme. In the second place, the treatment, use and consumption without authority of iron and steel in the production, repair or maintenance of articles not controlled under the Order, is prohibited. The main effect of the new provision will be to control the use of iron and steel by firms within the industry who also make products not subject to control. For example, an ironfounder cannot convert iron castings produced by him into stoves or baths without authority. In the third place, the quantity and value of material which may be bought without licence, by any one customer, from stockholding merchants, is limited. This supplements the arrangements already in force by which the quantities allocated to stockholders are retained. In addition, the new Order provides for control to be extended to cover iron powder, and carbon electrodes (except illuminating, welding or primary-battery electrodes). Apart from the exemption from licence of small purchases from stockholding merchants, as mentioned above, provision is made for the exemption of small purchases of certain materials, whether purchased from a stockholding merchant or a producer. The maximum prices for iron and steel products in the United Kingdom fixed under the new Order are in the main unaltered, but minor adjustments and additions have been made in the schedules.

UNION RESTRICTIONS IN SHIPYARDS.

The reference, in our leading article on "War Production," in last week's issue of ENGINEERING, to the persistence of trade-union rules which restrict output, receives confirmation in the report, in the *Daily Mail* of July 21, of an incident stated to have taken place recently in a Tyneside shipyard. It appears that a welder and his mate were urged to complete a certain piece of work as quickly as possible, to enable two gangs of riveters to start their operations on the same part of the structure. They did so, and put in 37 hours' work in 4½ days, for which they were reported by the shop steward to their union, the Boilermakers' Society, and fined 3*l*. each. Mr. Mark Hodgson, the general secretary of the Society, is quoted as having said that the men were not fined for working too hard, but for ignoring a rule "designed to protect their own interests." The wording of the rule is not quoted, and it is not clear exactly in what manner they have transgressed. Meanwhile, the fines have not been paid; but a report has been sent to the Minister of Labour (by whom, is not stated) and there is a possibility that the matter may be raised in the House of Commons. The resumed debate on production should afford a suitable opportunity.

MERCHANT SHIPPING LOSSES.

What may be the last announcement of shipping losses for some considerable time was made by the Admiralty on July 15, just too late for inclusion in last week's issue of ENGINEERING. It shows that the sinkings of British, Allied and neutral mercantile shipping during the month of June amounted to 79 ships totalling 329,296 gross tons. Of these 79 vessels, 52 were British, their tonnage being 228,284; 19, of 82,727 tons, were Allied; and there were eight neutral ships, totalling 18,285 tons. These figures show the substantial decrease, by comparison with those for May, of 25 ships and 168,551 tons, but they are still sufficiently serious and represent a rate of sinking considerably higher than the present rate of replacement. The lowest figure among the monthly sinkings during the past twelve months was that of January, 1941, when the losses amounted to 59 ships, of 309,731 tons—nearly 20,000 tons less than in June. Even the January rate, however, if continued for a year, would give an annual total of more than 3,700,000 tons, which is probably about twice the present rate at which the combined British and American merchant-ship building industries are producing ships that can take the place of those lost. The actual aggregate losses in the twelve months ended June 30, 1941, in round figures, are not far short of five million tons. This, of course, includes the severe months of April and May, 1941, when the military operations in the Mediterranean led to exceptional losses of both British and Allied ships. The causes of loss are relatively immaterial, however; the all-important fact is that the available tonnage has been reduced by an amount which represents a heavy additional burden upon the ships that still remain in service and upon the shipyards which must make good the loss. In the face of the figures, it is impossible to derive much satisfaction from the fact that the enemy claims totalled some 165 per cent. more than the actual sinkings, or that the losses of enemy tonnage (captured, sunk or scuttled) are reliably estimated to be some 3,390,000 tons from the beginning of the war to July 10 of the present year. Relatively to the shipping with which Germany and Italy entered the war, this is an enormous total; but, even in spite of the intensive bombing of enemy land communications, it cannot be supposed that either Germany or Italy depends upon seaborne traffic to the extent that Great Britain is obliged to do. The significance of the growing American contribution to the Allied shipping reserves is therefore evident. The output of the home yards, we understand, is very satisfactory in all the circumstances, but it can never offer the same opportunity for expansion as exists in the United States, where a yearly output of 6,000,000 tons is mentioned as being within the bounds of possibility, though not in this year or the next.

PRICE STABILISATION AND INDUSTRIAL POLICY.

A White Paper (Cmd. 6294), issued on Tuesday of this week, indicates in somewhat general terms the policy of the Government with regard to price stabilisation and industrial policy, more especially in connection with applications for increases of wages. The main methods of checking inflation, the White Paper points out, are additional direct taxation, rationing, and price control; all of which are actively in use to prevent rises in the prices of necessaries, and the equitable distribution of such limited quantities of consumable goods as are available. For these methods to be effective, however, it is essential that all engaged in industry should collaborate as closely as possible to avoid increases in the costs of production and the consequent rising prices which initiate the process of inflation. The maintenance of wages and of employers' remuneration should be ensured by improving the efficiency of production wherever possible; although it is admitted that there may be good grounds for wage adjustments in certain cases, especially among the lower-paid grades of employees, and where there have been changes in the form, method or volume of production. The policy of the Government, the statement continues, is to avoid modification of the existing machinery for wage negotiations, which has operated successfully hitherto, and "to leave the various voluntary organisations and wage tribunals free to reach their decisions in accordance with their estimate of the relevant facts." It is expected that due attention will be paid to such special grounds for adjustment as those mentioned above. If there were to be further increases in the cost of living, these also would have to be taken into account; but the object of price stabilisation was to prevent such increases, or at least to limit their extent. It would be necessary, therefore, for the tribunals and other organisations to bear in mind that wage increases would defeat their own object and the policy of price stabilisation would be made impossible, unless additions to wage rates were so regulated that prices and inflationary tendencies could be kept under control. The statement as a whole inclines to be advisory rather than definite, but it has called forth a prompt reply from the Trades Union Congress, who are strongly opposed to any attempt to control the upward tendency of wages. The General Council of the T.U.C., in a memorandum commenting on the White Paper, give it as their opinion that the Government's policy will induce employers to refer claims for increases to the National Arbitration Tribunal and the Industrial Court, which are likely to be influenced by that policy in arriving at their decisions. Moreover, it is suggested, the granting of increases may be made to depend, in the event, on the production of satisfactory evidence that the increases, if granted, will result in a greater output. The General Council express the belief that the control of profits and the encouragement of saving should provide sufficient safeguard against inflation, without interfering with the adjustment of wages; a policy which, they consider, "would undoubtedly cause undesirable repercussions."

OBITUARY.

COLONEL C. L. HOWARD HUMPHREYS, O.B.E.

IT is with regret that we record the death, on July 18, at Berrin's Hill, Ipsden, Oxfordshire, of Colonel Cecil Lee Howard Humphreys, who was appointed Director of Works in the Ministry of Works and Buildings last December. Colonel Humphreys, who was senior partner in the firm of Messrs. Howard Humphreys and Sons, consulting engineers, 17, Victoria-street, London, S.W.1, was born on September 7, 1893, and received his general education at Westminster School. After leaving school in 1911, he became an engineering pupil of Mr. A. W. E. Bullmore for a year and subsequently, from 1912 to 1914, served in a similar capacity under his father, Mr. H. Howard Humphreys. On completing his training, he acted as assistant to his father, but at the outbreak of war, four months later, he joined the first battalion of the Honourable Artillery Company as a private. He proceeded to France in September, 1914, and served on the Western Front and in Salonika and Palestine until January, 1919. He received a commission in April, 1915, and at the end of the war was serving as acting staff-captain to the 89th Infantry Brigade. After demobilisation he returned to his father's practice as chief assistant and was made junior partner in January, 1920. On the death of Mr. H. Howard Humphreys, he became senior partner.

Among other works he was responsible for 19 miles of sewers for the St. Albans main-drainage scheme, for 40 miles of sewers and 24 automatic pumping stations for Georgetown, British Guiana, and for similar schemes at Nicosia, Cyprus; Eastcote, Middlesex; Letchworth Garden City; Lagos, Nigeria, and elsewhere. In their capacity of consulting engineers for the Postmaster-General, Mr. Humphreys' firm carried out examinations, and drew up reports, concerning roads in all parts of the British Isles. He also inspected bridges for the London General Omnibus Company and other omnibus companies, and was responsible for a scheme for the reconstruction of Worcester Bridge over the River Severn. Mr. Humphreys and his colleagues and assistants designed and supervised the construction of waterworks at Jinja, Uganda; Kaduna, Northern Nigeria; Prestatyn, Wales; and Wallingford, Berkshire. He was also responsible for a scheme for ship locks at Faversham for the Faversham Navigation Commissioners, and, for the layout and construction of Crumpsall Vale railway for the British Dyestuffs Corporation.

Mr. Humphreys continued to serve in the Territorial Army after the last war, and, as Lt.-Colonel in the Royal Corps of Signals, proceeded to France with the B.E.F. in 1939. He was made an O.B.E. for distinguished services, and, after the evacuation of France, became Chief Signal Officer of the 3rd Royal Corps of Signals. Colonel Humphreys was elected an associate member of the Institution of Civil Engineers in 1921, a member in 1929, and was made a member of Council in the 1939-40 session. He was also a member of the Institution of Mechanical Engineers and of the Association of Consulting Engineers, and held the Territorial Officers' Decoration.

MR. E. KILBURN SCOTT.

ON page 57, *ante*, we referred briefly to the death of Mr. Ernest Kilburn Scott, which took place at his home in London on July 12. Mr. Scott was born in 1868, and was a native of Leeds, as he was always proud to affirm, and traced his descent from Christopher Scott, who was born in Armley in 1689. He was educated at the Leeds Middle Class School and at the Yorkshire College (now Leeds University), and commenced his engineering career in the textile-machinery works of Messrs. R. Kilburn and Sons, which was founded at Holbeck in 1810 by his maternal grandfather, Richard Kilburn. He gained additional experience with Messrs. John Fowler and Company, Limited, and as assistant to Mr. Wilson Hartnell, inventor of the Hartnell governor, before proceeding to Gateshead, where for some time he was chief turbine draughtsman to Messrs. Clarke, Chapman and Company. Subsequently he held similar positions with Messrs. W. T. Goolden and Company, London, in connection with electric coal-cutting and mining machinery; with Messrs. The Electric Construction Company, on power-station work and electric traction; with the Brush Engineering Company, as dynamo designer; and with Messrs. Johnson and Phillips, Limited, as estimator.

As chief inspecting engineer with the late Mr. Robert Hammond, M.I.E.E., Mr. Scott was closely concerned with the electric power stations at Ayr, Canterbury, Leeds, Wakefield, and elsewhere; and, overseas, at Madrid. In 1900, he went to Norway to report on a hydro-electric calcium-carbide plant, a branch of manufacture to which he devoted considerable attention in subsequent years. He also did some pioneer work in connection with the development of hydro-electric power in this country, being concerned more especially in the Snowdon district of North Wales, but he left this branch of engineering in 1904, on receiving an appointment as lecturer in electrical engineering at the University of Sydney, New South Wales. During his tenure of this position, Mr. Scott also carried out various consulting duties, mainly of a semi-official character, in connection with railway electrification, the use of electricity in mines, and the rating of electric-power and tramway undertakings. On returning to England, he was a lecturer for some time at University College, and at Finsbury College.

During the war of 1914-18, Mr. Scott was engaged in the Ministry of Munitions, particularly on questions of the production of nitrates and, in 1917, went to the United States in connection with the construction of a new Government plant to make ammonium nitrate. He remained for some time in America after the war, carrying out consulting and inspecting work for various financial corporations. On returning to England, he was engaged for some years in the application of pulverised coal in power stations, and in general consulting work. In recent years, he took a great interest in engineering history—especially that of Leeds—and in commemorating the work of pioneer engineers and scientists. He was chairman and principal organiser of the fund to put up a memorial to Matthew Murray. A later activity of a similar kind resulted in the erection, in Hatton-garden, London, of a chronological list of notable engineers, scientists, etc., from the Seventeenth Century onward, who had been associated with that district. Mr. Scott also contributed several papers to the Newcomen Society on the engineering pioneers of Leeds. He was a member of the Institution of Electrical Engineers and an associate-member of the Institution of Civil Engineers.

ECONOMIC CONTROL IN INDUSTRY.

By F. L. MEYENBERG, M.I.Mech.E.

"OUTPUT" is to-day's slogan, and rightly so; for each phase of the gigantic battle raging in the world shows clearly that no defect in the armour forged by modern industry can be mended in the long run merely by the fitness, or bravery of the human being inside the armour. But, wrong as it would be if this thinking in quantities were not coupled with the demand for quality—for a bad weapon may be worse than no weapon at all—it may prove as disastrous to forget that this output should not be obtained "at any price," but at the lowest cost possible; for even a big supply is not inexhaustible if demands so vast must be made on it. Thus the battle against waste joins with that for output and the original slogan develops into "quantity, quality and economy."

Unfortunately, the human mind is generally not accustomed to consider a problem simultaneously from several points of view and modern education and training, with the tendency to specialise more and more, have done much to increase this one-sidedness. The industrial undertaking has to provide, therefore, for an arrangement whereby the simultaneous consideration of various, equally important, but sometimes apparently contradictory aspects can be enforced as far as is possible in practice. This arrangement may be called "economic control," without, for the moment, defining in detail how it operates and to what extent it influences the various parts of an industrial works. One thing, however, is certain from the start: though an important part of the organisation, it is subsidiary to the main functions of the works and must adapt its methods to those functions so as not to interfere with them in any way.

This leads to consideration of the general structure of a works organisation. Although there is general agreement that the main principles are common to all branches of industry, such a confusion of ideas can be found in this sphere that the same expression is used for quite different subjects by different persons, and even by the same person, for various subjects on different occasions. This inexactitude only too easily gives rise to misunderstandings, and makes it advisable to give, at the outset, some definitions which may appear obvious but which are of service in obtaining and preserving a correct view of the subject.

An industrial works may be defined as any undertaking where raw material is transformed into goods by labour and these goods are sold to customers. That transformation, usually termed production, on the one hand, and the sales on the other hand, form the two fundamental and indispensable pillars of the undertaking. Although both are necessary and neither can exist without the other, discussion about their relative significance seems to be inevitable. The answer can only be that, if a difference in importance exists at all, it may be only temporary, and peculiar to the particular case, and may be reversed in course of time in consequence of changing circumstances.

Production and sales can also be described as the technical and the commercial sides of the concern; denominations which, perhaps, are preferable, as they have a more comprehensive meaning. They are linked by a third function: administration, which has rightly received more and more attention since the beginning of this century, much as it may have been neglected and even ridiculed in earlier stages of industry. Administration has been spoken of as a "science" and, while this may be an exaggeration, the growing importance of this kind of industrial function has been generally recognised; as is shown, for instance, by the fact that the Institution of Mechanical Engineers has included "industrial administration" as one of the subjects of examination for associate-membership. It is useful in many cases, for costing purposes, to divide administration into two parts, technical and commercial; but it will not fulfil its purpose satisfactorily if this division is carried so far as to separate the two parts completely, as is sometimes done. As administrative activity is necessary everywhere in a works, this fact should be utilised by making administration a connecting link between the often divergent and even seemingly conflicting interests of the technical and commercial sides of the concern. The nature of technical and commercial activity is so different, their tasks and methods may deviate so widely from each other, that such conflicts of opinion should not cause surprise. Obviously, however, opposition of this kind must be overcome by a suitable compromise, but often special measures of organisation are needed for this purpose, calling for firm but smooth handling if the ultimate aim, the prosperity of the concern, is to be attained.

All these considerations were, of course, unnecessary as long as the industrial structure was simple and the form of a concern was the one-man business or at least did not deviate largely from it. At that time the above synthesis took place in the head of that one man, very often, perhaps, unconsciously; no real organising work was necessary, but the more the division of labour developed not only in the range of manual work, but also in mental activities generally and in administrative work in particular, the more the necessity of organisation was felt, the result of which has been shown in the definition that "organisation is the art of using the advantages of the division of labour, and of simultaneously avoiding the disadvantages connected with it, as far as possible in given circumstances."* It is important to make it clear at this point that administration and organisation are not

* See *The New Management*, by Hildage, Marple and Meyenberg. London: Macdonald and Evans. (1938.)

identical ideas though, unfortunately, they can be found used for one and the same function not only in practice, but also in publications. Organisation is only the arrangement of administrative work, the fixing of general principles and rules; organisation prevents overlapping and repetition between departments, but it does not carry out administrative measures. That is left to administration proper and although, from the point of view of the whole concern, organisation can be considered as a part of administration—in fact, as one of its instruments—the two are as different as, for example, planning the production of steam turbines in a new factory and carrying out a special order for such a turbine when the factory is working. Where an organising superintendent has been appointed in a works, he will carefully examine the programme of work for the various orders, but he will not interfere with the arrangements made by the production manager; he will draw his conclusions from any delays and friction that he may have observed and try to rearrange the organisation so that these difficulties may be avoided in the future. Administrative work, on the other hand, deals with all the details of running the business, from giving decisions in special cases down to the routine work of writing material requisitions, and wages tickets, or from the financial operations of investing funds to ensuring that figures are booked to the correct accounts.

The function described as "management" is, perhaps, even more closely associated with administration than is organisation. This expression has many everyday meanings and is often used instead of the clumsier "administration," but in industry it tends more and more to mean some leading activity as shown in the terms managing director, general manager, works manager, etc., and it is useful to limit it strictly to this meaning. Management, like organisation, is also a part of administration, but it takes a special position in relation to the various divisions of administration in that it overrides them all; thus, a general manager can be his own organiser, but he can also depute someone else to do this work temporarily or permanently. Even in the latter case, however, he retains the power of ultimate decision. As already indicated, these definitions may not be generally accepted, but they have been found useful for avoiding misunderstanding when matters of this nature have been under discussion and it seemed advisable to establish clearly the relationships between these functions.

How does this "economic control" fit into the system of a works which is formed by the technical side, the commercial side and administration? Of course, it must be a part of the administration and it is generally agreed that the operations which comprise accountancy, costing, records, statistics, etc., effect economic control to the extent that they verify whether the various processes going on in the works are carried out with the best possible economy; but the question arises, whether this part of administration, which may be comprehensively termed "industrial accounts," is really sufficient for the purpose of "economic control," *i.e.*, for examining and for guaranteeing that everything has been and will be carried out to the standard best suited to its purpose, at the stipulated time, and with the least expense possible when using the existing plant and equipment. That is what the expression "economic control" really means or should mean; and it is obvious that it involves much more than merely keeping accounts expertly and carefully.

In general, accounts relate mainly to money, but economic control extends, as the occasion may require, to measures of quantity, weight, dimensions, number of pieces, etc., and of time; and it does this as long as possible, before transferring these measures into money figures, because this conversion may cause uncertainties or mistakes, rendering the drawing of conclusions from the figures more difficult. On the other hand, money alone can be used as the common denominator necessary for summarising, and obtaining a general survey.

Another point to be kept in mind in connection with economic control is that this activity is not only retrospective but also has to draw conclusions from past experience and to show how errors and mistakes can be avoided in future. Finally, there is nothing in the works that can be considered as outside the sphere of economic control, from the design of the goods, through the planning and preparation of production and actual manufacture, to the dispatch of the goods to the customers and perhaps erection on site. The purchasing of raw material, its testing, transport and storage, financial transactions to obtain the necessary capital and the provision of ready cash for the wages and salaries are all parts of the same study; and, if economic control performs its full duty, it must not forget to control itself, but must take care that the control is always governed by the idea of economy and that the profit from the measures taken is higher than their costs. This last demand is more easily made than carried out, for the profit and sometimes also the costs cannot always be expressed completely by money, and it must be left to the responsible man to decide how high he may set their value in each particular case. This point of view may also be of importance in other cases; for by defining economic control as a matter comprehending much more than the industrial accounts alone, the foundation of facts has been abandoned to some extent and reliance placed on estimation based on experience and common sense. That may be considered as a drawback by those who believe in the absolute truth and reliability of accounts, but the expert more familiar with and always conscious of the "relativity" of such accounts, as a basis for anticipating future developments, knows only too well that actually nothing new is introduced into economic control by using estimation. It might be an advantage if this were better appreciated by all concerned than as it is sometimes the case at present. The danger that the keeping of industrial accounts may degenerate into a mere mechanical accumulation of figures is certainly diminished.

The most important point, however, is that by embracing all measures for proving and verifying the economic results of the several parts and functions in a business and by drawing the correct conclusions from these observations, close connection is established between the various investigations and surveys carried on in different departments of a works. Too often these are conducted quite independently of each other, and even sometimes unknown to each other, especially in large works where specialisation has been very fully developed. This is a serious handicap, and it is high time that proper organisation should be devised to prevent it.

For this purpose, it is useful to remember what checks are used, in addition to the industrial accounts, to determine the economic result of various processes, or to improve on some special method of working. Apart from laboratory work, which may be left out of this consideration, a large amount of research work is carried out continuously through the whole concern, partly as a matter of routine and partly in the form of special investigations. This can be summarised under the four headings of inspection and testing, organisation studies, work and time studies, and industrial accounts and costing studies.

The duties indicated by these four headings are usually the responsibilities of four or more departments, but the way in which they function recalls only too often the familiar experience in towns where there is no co-ordination between the public services and the gas, water, electricity and postal authorities in turn, break up and re-lay the same street, instead of combining to make one operation of it. Indeed, it is even worse than in this simile, for the various kinds of surveys can often learn so much from each other that co-operation would make the result of each more valuable and, in many cases, only a combination of two or more of these methods of investigation can bring complete satisfaction. Only in exceptional cases would it be possible to form a single department for all four together, but some way must be found to bring them together as closely as possible, in conformity with the organisation of the particular undertaking. Economic control in a works is a whole with various branches, and the more the organisation reflects this fact and the close coherence between the individual functions, the more effective it is.

(To be continued.)

RUSSIAN INLAND WATERWAYS.

THERE have been many references during the past ten years, most of them rather vague in matters of detail, to the efforts made by the Government of the U.S.S.R. to improve and extend the inland waterways which play so prominent a part in the internal transport arrangements of Russia. To a large extent, these consist of the great river systems of the country, but the canals are also very important, and some of them are of considerable antiquity, dating from a period between 150 years and 200 years ago. The natural waterways aggregate about 250,000 miles in length available for navigation, but, before 1930, comparatively little had been done to link them into a unified system based on definite strategical and commercial objectives. Something of the developments that have been undertaken since that date is indicated on the map, on page 76, and in the notes which follow.

The ultimate aim is to connect the Baltic, the White Sea, the Caspian, the Sea of Azov, and the Black Sea by a system designed to counteract the military disadvantage, under which Russia has always laboured, of being obliged to maintain separate fleets in European and Mediterranean waters. This would not entirely obviate the need to base a separate naval force in the Far East, but that disability has also been met to some extent as a result of various expeditions to the Arctic and the successful charting of a route from the White Sea to the Behring Strait, which has been regularly traversed in recent years, during the summer months. This development, however, has been dictated as much by commercial as by strategical considerations, whereas military strategy alone inspired the construction of the Stalin Canal between the Baltic and the White Sea. When the system between Western Russia and the Black Sea is completed, it will have definite defensive importance, as the intention is to maintain such a depth of water throughout as will enable light cruisers to pass from one area to the other. Meanwhile, however, the benefits of the enterprise are mainly industrial. New manufacturing districts have been opened up, and appreciable relief afforded to the overtaxed railways.

The Baltic-White Sea route consists of the Rivers Neva and Svir and the Imeni-Stalin Canal, and is about 560 miles long. The two locks on the Svir are not yet in use, but one has been completed and the other is under construction. A temporary by-pass canal has been cut to enable some traffic to use the route, pending the completion of the locks. On the Imeni-Stalin Canal there are 19 locks, mainly of wood and built in 1932. They are 379 ft. long, 50 ft. wide, and 15 ft. deep. The depth of water in the canal itself is only 12 ft., but it has been reported that a number of small naval craft, including submarines, succeeded in escaping through it when the German forces attacked the Baltic coasts and frontiers of Russia.

The Marinski system connects Leningrad to Ribinsk, on the Volga, but at present is of limited utility, having 43 locks and being capable of passing only barges not exceeding 800 tons. Plans have been prepared to modernise the system by increasing the depth and reducing the number of locks to six. The Moscow-Volga Canal, 80 miles in length, which was completed in 1937, is of more adequate dimensions, being designed to take vessels drawing from 15 ft. to 18 ft. of water, but it is not yet used by ships of this draught owing to limitations imposed by adjacent sections of the general canal system, where reconstruction is still incomplete. The Manych Canal, connecting the head waters of the river of that name with those of the River Kuma, was to have provided a passage from the Black Sea to the Baltic via the Caspian Sea and the Volga; but its construction is understood to have been abandoned, although in a fairly advanced state. One main reason is believed to be the difficulty of navigation in the Caspian, which is subject to violent storms, and the level of which is steadily falling; but it is probable that the decision not to proceed with the Manych system was influenced by the superior possibilities offered by the Volga-Don Canal, which

will join these two rivers immediately below Stalingrad, so linking the Black Sea with the main canal system. This link is understood to have been begun in 1939, and to be designed for a minimum depth of 21 ft., which would enable light cruisers of moderate size to make the passage; but, in the most favourable circumstances, it cannot be completed for several years. An additional benefit to be expected from it is a check to the falling level of the Caspian, due to the present inflow being less than the loss by evaporation. The canal should retard this loss to some extent by diverting the waters of the Don into the lower Volga.

There are other minor canal systems which, though of technical interest, cannot compare with the foregoing canals in strategic importance. They include the Tikhvinski and Vishnivolotski systems, connecting the Volga with the Baltic; the Hertzog Wurtemburgski Canal, between the Volga and Dvina rivers, and linking the Volga with the White Sea; the Sergeitch Canal, in the Minsk region, which connects the Dnieper with the Western Dvina by way of the River Berezina; and the Dnepropetrovsk Canal, past the rapids on the Dnieper between Dnepropetrovsk and Zaporozhe. This was constructed as part of the Dneprostroi power-station scheme, and was opened for steamer traffic early in 1932. It is reported that the water supply to the Sergeitch Canal is failing and that, in consequence, this waterway is now used only for rafting timber.

LUMINESCENT SIGNS.

THE useful range of employment of luminescent materials, generally familiar in connection with watch dials, has been greatly extended by the conditions of nightly black-out. The after-glow properties of these materials may find valuable application for A.R.P. signs and shelter entrances, also for instrument boards with which, owing to difficulties of obscuration, ordinary shaded lights cannot be employed. By using phosphorescent materials, the field of supplementary low-power lighting may be considerably extended. Emergency illumination of this class may be used to furnish sufficient light in underground shelters to permit movement in case of failure of the ordinary lighting. Similar application to signs in factories will facilitate the evacuation of workpeople in case of damage to supply mains. Further possibilities are in connection with articles of wear for pedestrians and traffic-control signs.

The whole of this subject is dealt with in useful detail in Bulletin C. 17 of the Research and Experiments Department of the Ministry of Home Security. It defines luminescent materials as those which can be made to emit light by means other than heating to incandescence. Excitation may be caused by X-rays, ultra-violet and visible radiation, by chemical changes and by friction, but only ultra-violet and visible-ray excitation is dealt with. The materials fall into two classes, fluorescent and phosphorescent. Fluorescent substances have the property of absorbing radiation within a certain range of wavelength, by this means being excited to emit radiation of longer wavelength. The fluorescence continues only so long as the material is irradiated. Phosphorescent material, on the other hand, continues to glow for some time after excitation has ceased. The duration of after-glow varies widely in different materials; in all, however, its intensity fades rapidly at first and then more slowly. British Standard Specification BS/ARP 18 distinguishes between two types of phosphorescent materials: those which have a high brightness during and for a short time after irradiation, but a short after-glow, and those which have at first a lower brightness but a longer after-glow.

Many organic materials, including various oils, greases and resins, are fluorescent. Some of them have been employed in the production of fluorescent paint, but there is a tendency for them to be washed out of the surface layer on weathering. To obtain phosphorescence, it is necessary to use inorganic compounds. Those most commonly employed are zinc and zinc-cadmium sulphides, and alkaline earth sulphides. The former belong to the first class of BS/ARP 18. With proper selection of materials, good durability can be obtained. Shielding from direct sunlight is generally desirable, otherwise darkening may occur, although it will not necessarily be permanent. Luminescent signs having a long life may be prepared by incorporating zinc sulphide in a vitreous enamel before firing.

Alkaline-earth sulphides belong to the second class, exhibiting lower initial brightness but longer after-glow. Calcium sulphides have good stability, but the commercially available material gives a deep violet glow to which the eye is relatively insensitive.

RUSSIAN INLAND WATERWAYS.

Strontium sulphide gives an easily visible blue-green glow and has been largely used by manufacturers of luminescent paints. It is, however, unstable in presence of atmospheric moisture and careful precautions in manufacture, storage and use have to be taken. Special undercoats and protective varnishes are provided by manufacturers, but the Bulletin states that the most satisfactory system of protection is the enclosure of the strontium-sulphide paint between two sheets of glass with the edges sandwich waterproofed.

In the application of phosphorescent materials, irradiation is by daylight or artificial light sources, but for fluorescent substances continuous energising by ultra-violet radiation is necessary. Mercury-vapour lamps with black outer bulbs may be used for this purpose. They are powerful sources of long-range ultra-violet radiation and a single lamp may be used to energise fluorescent markings over a wide area and at distances of 50 to 100 yards. Such lamps have a discomforting dazzling effect caused by the fluorescence of the eyeball of the observer and must be screened from direct view, and also from above. The argon glow lamp is another, but much weaker, source of ultra-violet radiation. It is convenient for energising fluorescent signs at distances of a few feet.

Limits of brightness for standard A.R.P. signs are laid down in Specification BS/ARP 32. These limits are readily obtainable with a 5-watt argon lamp, but it is advisable to use an aluminium reflector to concentrate the ultra-violet radiation on the sign face. An objection is the restricted life of the argon lamp. A tungsten-filament lamp is superior in this respect, but the running expenses are greater, as a 40-watt tungsten lamp is necessary to give the same effect as a 5-watt argon lamp. For switch rooms in which ordinary lighting may not be practicable owing to difficulties of obscuration, the Bulletin suggests a mercury lamp and the marking of instruments and switches with a fluorescent material. If this is also phosphorescent it will have the advantage of exhibiting after-glow should the source of irradiation temporarily fail. Zinc-sulphide pigments are recommended.

In connection with the use of phosphorescent substances for signs and obstruction marking, the Bulletin states that their limitations should be fully realised. None of the materials so far available can be relied upon to remain usefully visible throughout the night after excitation by daylight. With good quality strontium or strontium-sulphide, the markings will be usefully visible for about four hours after sunset on a moonless star-lit night. For several hours more they may be discernibly brighter than similar markings in white paint, but after that the white paint is equally, if not more, efficacious.

THE BRUSH COMPANY'S APPRENTICESHIP SCHEMES.

AMONG the uncertainties of the future, one matter is clear: progress and the welfare of the country in the post-war years will be conditioned, if not determined, by the status and efficiency of the engineering industry. The sudden cessation of munitions manufacture will introduce many problems which, to a large extent, must be left to be dealt with as they arise. One item in their solution may, however, be formulated at the present time: that is provision for an adequate supply of men trained so that they shall be capable of maintaining this highly technical industry in a position of international pre-eminence. In the present circumstances, some slackening in the attention paid to the training of the young men might appear to be excusable and it is heartening to find that the Brush Electrical Engineering Company, Limited, Loughborough, have found it possible, even under present conditions, to reorganise their apprentice training programme.

The system now in operation, like some others, covers training for three classes of apprentice—trade, student and college. Arrangements are also made for undergraduates to attend apprentice courses during the long vacation. Trade apprentices, who enter the industry with the idea of becoming craftsmen, although there is nothing to prevent them from rising to higher positions should they have the ability, pass through a five-year course, from the ages of 16 to 21. Should they enter the works under 16, they are given temporary employment until they reach that age. They are drawn principally from senior and central schools or junior technical schools. A tribute to the good work being done by these latter schools, of which there are still too few, is paid by the Brush Company in its strong recommendation that boys intending to become trade apprentices should endeavour to enter a junior technical school.

The student apprenticeship course is intended for those who enter industry from school (usually a public or grammar school). They are required to have passed London matriculation, or some equivalent examination. They are taken between the ages of 17 and 19, and pass through a four-year course, specialising in either electrical or mechanical work during the latter three years. They are expected to study for and take the graduate examination of either the Institution of Electrical Engineers or the Institution of Mechanical Engineers. Unlike the other classes of apprentice, student apprentices are charged a premium of 150 guineas, which is returned as wages during the first three years. The reason for this differentiation is that while trade apprentices remain at their selected trade and soon reach an earning stage, and college apprentices are of maturer years and quickly do work of value, student apprentices pass from department to department for their own educational benefit, so that it is some time before they can usefully contribute to shop or office output.

College apprentices take a two-year course, which gives them the practical training necessary for associate-membership of the Institutions of Mechanical or Electrical Engineers. The necessary theoretical training will have been obtained in the previous three years at college, or in the course of the sandwich system which can be arranged. This two-years' training does not in itself qualify for associate membership, the Institution of Electrical Engineers, for instance, requiring three years at college, a two-years' workshop course, and a further two years of responsible experience. As the Brush Company is particularly anxious that its college apprentices shall eventually become chartered mechanical or electrical engineers, every effort is made to provide the two years further training and responsible experience which is necessary.

MONEL METAL IN THE TANNING INDUSTRY.—Slings employed for the immersion of bundles of hides in tanning liquor are now being made of Monel wire rope. This material is unaffected by the liquor, whereas iron and other metals tried are attacked and cause undesirable darkening of the liquor.

THOMAS GRAY MEMORIAL PRIZE.—The Council of the Royal Society of Arts has awarded the 1940 Thomas Gray Memorial Prize of 50*l.*, for the improvement and encouragement of navigation, to Mr. H. C. Walker, of Cheam, Surrey, for a device known as the "Portable Valve Lifeboat Equipment." This is a self-contained radio auto-transmitter designed for the purpose of saving life at sea. A similar prize of 50*l.* is offered, for 1941, for an invention considered to be an advancement in the science or practice of navigation, proposed or invented during the period January 1, 1936, to December 31, 1941. Competitors must forward their proofs of claim between October 1 and December 31, 1941, to the Secretary of the Society, John Adam-street, Adelphi, London, W.C.2.

LABOUR NOTES.

WITH the approval, it is understood, of the Joint Consultative Committee of employers and trade union representatives, the Minister of Labour and National Service has made an important alteration in the Essential Work (General Provisions) Order. Under the Order as it originally stood, an employer could suspend a man from work, but, if he did, he was obliged, in an undertaking to which the Order applied, to continue to pay the man's wages. In the Order, as amended, loss of pay will accompany suspension; but to protect a man from arbitrary or unjustifiable punishment, he is given a right of appeal to a local appeal board. The Order, as revised, provides that when an employer suspends a worker in accordance with his conditions of service for a period not exceeding three days, the worker will not be entitled to be guaranteed wages for the days on which he is suspended unless (1) he appeals to the Local Appeal Board within three days of the beginning of the suspension, and (2) either the Board is unanimously of the opinion that the suspension was unjustified, or, if the Board is not unanimous, the National Service Officer is of the opinion that the suspension was unjustified.

When the decision is in the worker's favour, he will be paid the guaranteed wage for the period of suspension. When it is against him, he will lose the guaranteed wage for the three days, but not for the rest of the week. If a time worker, he will be entitled to a proportionate minimum wage for the days on which he works. As the piece worker's minimum wage is calculated by the day, the same assurance is not required in his case. Discussions will now proceed, it is stated, with the object of similarly amending the Orders affecting particular industries.

The text of an agreement between the Amalgamated Engineering Union and the Transport and General Workers' Union, covering the case of men belonging to the latter organisation who are up-graded and registered under the dilution scheme, is given in the July issue of the *A.E.U. Monthly Journal*. Included in the membership of the Transport and General Workers' Union is the National Union of Enginemen, Firemen, Mechanics and Electrical Workers which forms its Power Workers' Group. Under the agreement, members of the Transport and General Workers' Union who are up-graded and registered under the dilution scheme are to "be advised and expected to take out a temporary card of membership in the Special Relaxation Section of the Amalgamated Engineering Union for the period of such up-grading, and at the same time be required as a condition of such membership to retain their membership of the Transport and General Workers' Union." Members of the Transport and General Workers' Union who have served their time in the engineering industry and who are released from their present occupations in order to return to the engineering industry for war purposes" are to be "advised and expected to take out a card of membership in the Amalgamated Engineering Union in their appropriate section and be required as a condition of such membership at the same time to retain their membership of the Transport and General Workers' Union in consideration of the fact that they will in all probability desire to return to their previous employment at the expiration of the war."

The officers of the two unions are to co-operate to the fullest possible extent in securing compliance with the foregoing provisions. Joint committees are to be established in the districts, and meetings of such bodies may be convened, it is agreed, at the request of either of the contracting unions. Questions which cannot be settled in the districts are to be referred for decision to a National Joint Council composed of representatives of the two executive councils.

In June, the home branch membership of the Amalgamated Engineering Union increased from 496,544 to 500,118, and the Colonial branch membership from 45,170 to 46,431. The number of members in receipt of sick benefit decreased from 4,975 to 4,683, and the number of superannuated members from 13,291 to 13,276. The number of members in receipt of donation benefit decreased from 568 to 435, and the total number of unemployed members from 2,147 to 2,015.

The writer of an editorial note in the July issue of the Amalgamated Engineering Union's *Journal* declares that "a crude 'stop' to wage movements, such as is proposed by some authorities . . . is unthinkable." "It would," he goes on to say, "stereotype and fix the wide variations in the wages of different bodies of workpeople. If it was applied at this moment, it would mean that the wage-earning class as a whole would be at least 7 per cent. worse off than they were when the war began. And every uncovenanted increase in the price of commodities or services which the working people have to pay would worsen their position. For instance, there are seasonal fluctuations in prices of household necessities. Will the Government system of price regulation and rationing guarantee that no increases will take effect on this account? And there are other factors operating which make the purchasing power of wages an unstable quantity. To talk of stabilising wages in these circumstances is a mockery."

After a discussion which spread over practically two days, the conference at Ayr last week of the Mineworkers' Federation of Great Britain accepted, with two dissentients, the executive committee's report on the application to the industry of the Essential Work Order. The attendance bonus was also approved, but the executive undertook, on the suggestion of Lancashire, again to approach the coal-owners with the object of inducing them to withdraw the conditions attached to it. Only men who work an unbroken week are entitled to the attendance bonus.

The following resolution was adopted unanimously:—"The conference regrets the action of the Labour Party and the T.U.C. General Council in failing to implement the resolutions relating to nationalisation, and reiterates its demands for the nationalisation of the coal-mining and ancilliary industries with effective workers' control."

A resolution submitted by Scottish and Cumberland delegates asked for a guaranteed wage of 4*l.* 10*s.* a week, plus any increase due to war conditions' agreements. The executive were requested to place the claim before the Government, and to call a special conference to consider the result. Mr. Lawther, the President, said that the effect of the resolution, with the war addition, would be a demand for a guaranteed wage of 5*l.* 12*s.* a week, with any further additions that might be made under cost-of-living arrangements. The demand would mean a definite advance in the price of coal in order to meet it. The resolution, if carried, would place them in the position of having to go to the Government and say that "the price of coal must go up." The resolution was referred to the executive.

According to the latest official *Trade Report* of the United Patternmakers' Association, the membership of the organisation "steadily rises." "To the 12,872 shown in our total, we look forward," Mr. Findlay, the general secretary says, "to an addition of 21 next month. . . . The admissions are less by 15, while the recissions are more by 10. The number of new members was 52, while deaths, resignations and exclusions were 41." The unemployment figure is down from 31 to 26, and the number of members in receipt of sick benefit from 238 to 211. The number of superannuated members shows no change at 674.

A statement on the progress of the arrangements for the concentration of industry was made at a conference at the Board of Trade on Thursday last week. According to it, estimates show that the workers released, and to be released by schemes now under consideration total, 110,000. Before concentration, the number employed in the industries from which the 110,000 have been, or are about to be, released was 700,000 or 750,000. Of the remaining 600,000, some are engaged in making articles for export and a large number in work for the Government.

Under an agreement to which the shipbuilding employers and shipyard trade unions on the United States Pacific coast are parties, the basic wage rate of "standard skilled mechanics" is fixed for the period of the emergency or two years, whichever is the longer, at 1 dol. 12 an hour. The working week is to consist of four days, each of eight hours, and overtime is to be paid for at the rate of time and a half. Work on Saturdays is also to be paid for at the rate of time and a half, and work on Sundays at the rate of double time. Lock-outs and strikes are prohibited. The agreement has the approval of the United States Navy, the United States Maritime Commission, and the Office of Production Management.

OXY-BUTANE BRAZING OF CAST IRON.—A description is given in a recent issue of *The Mechanical World* of the use of an oxy-butane flame for brazing cast iron. It is stated that as the temperature of this flame (2,800 deg. C.) is less than that of the oxy-acetylene flame (3,000 deg. C.) there is less volatilisation of the zinc in the brazing metal, and the wearing of goggles is unnecessary.

CORROSION OF COPPER ALLOYS IN ATMOSPHERES POLLUTED WITH COAL SMOKE.*

By S. C. BRITTON, M.A.

SOME exposure tests of sheet metals and protective coatings, which have been made in a railway tunnel, have been described elsewhere.† The behaviour of copper and its alloys in these tests was, in general, good, and showed some features that seemed worth a more detailed account than could be given in the general report on the tests. Other tests, in which wires of cadmium-bronze and tin-bronze have been in service in signal operation in tunnels, have also given results of interest. In both tests the rapid building up of dense layers of corrosion product was noteworthy, and the nature of these products has now been investigated. The behaviour of aluminium bronze gave rise to some laboratory work on the selective corrosion of this material, and the results are now presented.

Exposure Test.—To assist in the design of ventilating equipment to handle the exhaust gases of steam locomotives, tests of a large number of metals and protective coatings were made in a ventilating shaft of the St. Pancras tunnel of the London Midland and Scottish Railway. The arrangement and general results of these tests have been described elsewhere‡ and it is now only necessary to give brief details. Two types of test-piece were prepared from 14 S.W.G. sheet, which, for copper and its alloys, was hot-rolled. Curved sheets, each 1 ft. broad and forming a quadrant of a cylinder of 2 ft. radius, were arranged 12 ft. above the line of passage of locomotive chimneys. Other test-pieces, bent to give two 1-ft. squares, one horizontal and the other vertical, were placed so that the exhaust gases from the locomotive chimneys were deflected on to them by the curved plates. The passage of the gases over the angular plates was also assisted by a fan exhausting from the tunnel for discharge to the open air.

The deposits of soot and ash which fell upon the exposed specimens remained continually moist. A typical deposit remaining on 100 sq. cm. of glass surface after exposure for 14 days, contained the following matter, expressed in milligrammes:—Water, 1,590; tarry matter, 2·7; other carbonaceous material, 154; insoluble mineral matter (ash), 100; soluble sulphates (expressed as SO_3), 19; soluble chlorides (expressed as Cl), 9; soluble lime (expressed as CaO), 4·7; and soluble iron (expressed as Fe_2O_3), 14·3. The sulphur dioxide content of the atmosphere varied with the frequency of passage of trains, the range being between 2 parts and 9 parts per million. The total time of exposure was 3½ years. During this period unprotected test-pieces of mild steel were completely destroyed by corrosion, and those of austenitic stainless steel, stainless iron, and aluminium were perforated at many places. The extent of the losses from the copper alloy specimens is shown, together with the compositions of the alloys, in Table I. Measurements were made both by micro-examination of sections of the sheets mounted in Bakelite and, after the corrosion product had been scraped away, by a ball-ended micrometer applied to portions of the test-pieces that had been measured before exposure. There were no pits, so that these methods gave a reasonable measure of damage.

In outdoor tests at Birmingham, copper was found by J. C. Hudson, in one-year tests, to lose about 0·15 thousandths of an inch per annum and by J. H. Friend, in seven-year tests, to lose about 0·08 thousandths of an inch per annum. The rates of corrosion observed in the tunnel were thus of the order of ten times those expected in the open air over a similar period of time.

Tests of Wires.—Galvanised-steel wires used to operate railway signals have very short lives in tunnels used by steam trains, sometimes as little as six months. Experiments have, therefore, been made with two copper alloys, which, when hard drawn, had the necessary mechanical properties. These were bronzes containing 2 per cent. of cadmium or tin. Wires consisting of seven No. 17-S.W.G. strands were put into service in four tunnels of the London Midland and Scottish Railway in 1936. The wires were supported on pulleys at the side of the tunnel about 18 in. from the ground. It became evident after a brief experience that, although the wires were behaving well, the galvanised iron pulleys over which they ran were being corroded much faster than their neighbours carrying galvanised wires. A trial was therefore made of pulleys machined from a commercial Bakelite fabric laminated sheet material, produced for service in the chemical industry. In Table II are shown the breaking loads of samples of the wire before and after use for 40 months in two tunnels. The test samples were taken from lengths between pulleys.

The wires had suffered rather more loss in strength where they had been rubbed on pulleys. Nevertheless, much of the wire was considered still serviceable after 40 months and was permitted to remain. During this first 40 months of life, galvanised wires running parallel with the copper alloy wires in Woodside Tunnel had to be replaced six times. Thus, in spite of the higher initial cost of the copper alloys, installation and renewal costs for a copper alloy wire after 40 months were only one-third of those for galvanised wire. The Bakelite-fabric pulleys appeared almost unchanged by their service.

Investigation of Corrosion Products.—Vernon and Whitby have shown that the green layers that form on copper after prolonged exposure out-of-doors consist of basic copper salts. These salts have great stability, and it is thought that they greatly retard the corrosion of the metal beneath. The sheets exposed in St. Pancras tunnel became covered with green layers after a few months, following a preliminary stage in which drops of green-coloured liquid had been observed on the metal. The bronze signal wires acquired a complete green coating between their individual strands, but not on the outside surfaces. It seemed worth while to determine whether the corrosion products formed were of the same type as those found out-of-doors, since this might be some guide to the prospective rate of corrosion over longer periods than the 3½ years of the tests. The corrosion products were scraped from the sheets after the deposit of soot, about ¼ in. thick, had been washed off, and were obtained from the wires by simply opening out the strands. Three methods of examination were used, namely, observation of sections with the microscope, chemical analysis, and estimations of refractive index.

Examination of sections with the microscope was made after specimens had been mounted in Bakelite in a press and polished by hand. The mounting involved heating to 160 deg. C., but no changes visible to the eye occurred on heating the coated metal in the same way when not in Bakelite. It was found that all the test-plates from St. Pancras tunnel had a discontinuous layer of porous metallic copper about 0·0008 in. thick on the surface of the corroded metal. On Everdur and aluminium bronze 11, this deposition of copper had also occurred at grain boundaries, where intergranular corrosion had taken place (Figs. 1, 2 and 6, opposite). The wires did not have this copper layer, but they had, next to the metal, a layer that appeared to be cuprous oxide. Surrounding the inner fragmentary layer, both plates and wire had a compact mass of green material, which was free from inclusions of copper or oxides of the metal or of carbonaceous matter.

The results of chemical analyses and the estimations of refractive indices, as well as the microscopic evidence, all indicated that the corrosion products consist of compact layers of basic sulphates and chlorides similar to those that appear to give so much protection to copper after it has been freely exposed out-of-doors. There is thus a hope that the rate of corrosion will be slower in further periods of exposure than it was during the initial period. It is noteworthy that, even during the test period, the least corroded sheets were those of copper and Everdur, to which the corrosion product adhered best, and that the interior of the wires, where the corrosion product was retained between the strands, was far better preserved than the exterior. The small amount of nickel in the final corrosion product of cupro-nickel is no doubt due to the washing out of nickel salts, which as Vernon has shown become insoluble basic compounds only very slowly on exposure. Hudson has found a similar effect out-of-doors. The selective solution of part of the corrosion product on this alloy probably accounts for its flaky nature, also observed by Hudson.

The large quantities of chloride found in the corrosion products are remarkable, since Vernon and Whitby have always found that sulphates predominate in the corrosion products occurring on copper remote from marine influence. The deposit collected on glass in St. Pancras Tunnel contained about half as much chloride as sulphate, and was therefore not unduly rich in chlorides when compared with deposits in inland towns, as shown in the Annual Reports of the Department of Scientific and Industrial Research on "The Investigation of Atmospheric Pollution." There is, of course, chlorine in coal and it has been calculated that a locomotive firebox atmosphere might contain 0·1 per cent. to 0·01 per cent. by volume of hydrochloric acid. The tunnel chlorides probably came from this source.

Copper is normally corroded more rapidly by chlorides than by sulphates, either in neutral or in acid solution. Vernon showed by laboratory experiments that an atmosphere of 50 per cent. relative humidity containing 0·01 per cent. of hydrochloric acid corroded copper much faster than a similar atmosphere containing 1·0 per cent. of sulphur dioxide, and as fast as one containing both 0·01 per cent. hydrochloric acid and 1·0 per cent. sulphur dioxide. The product formed was cuprous chloride. Further, copper sulphate absorbs hydrochloric acid. It is therefore surprising, in view of the presence of chlorides in the atmosphere, that all atmospheric corrosion products of copper do not contain substantial amounts of chloride. It seems likely that the corrosion process in the tunnels, and possibly in atmospheres rich in sea-salt, follows a rather different course from that taken inland in the open air.

The corrosion products formed in the tunnels resemble,

TABLE I.

Specimen No. and Particulars:—	12 (Angle). Copper.	10 (Angle). Everdur.	9B (Curved). Everdur.	9 (Angle). Cupro-Nickel.	11 (Angle). Aluminium Bronze.	2B (Curved). Aluminium Bronze.
Analysis (per cent.)						
Copper ..	99·7	96·0	95·8	79·9	91·0	90·3
Nickel	—	—	—	19·9	—	—
Aluminium ..	—	—	—	—	8·6	9·1
Iron	—	—	—	—	0·3	0·5
Manganese ..	—	0·9	1·0	—	—	—
Silicon	—	2·8	3·0	—	—	—
Arsenic ..	0·19	—	—	—	—	—
Effects of Corrosion:						
Loss of metal ..	Uniform loss of thickness of 0·005 to 0·007 in.	Uniform loss of thickness of 0·005 to 0·007 in. with, in addition, intercrystalline penetration to a depth of 0·005 in. from each surface (Fig. 2, opposite).	Uniform loss of thickness of 0·005 to 0·007 in. with, in addition, intercrystalline penetration to a depth of 0·005 in. from each surface.	Uniform loss of thickness of 0·008 to 0·010 in.	Loss of thickness rather patchy, varying between 0·007 and 0·012 in. with, in addition, some intercrystalline penetration to a depth of 0·001 in. from each surface (Fig. 6, opposite).	The β phase in this alloy had been selectively corroded, copper - coloured residue being left, to a depth of 0·025 in. from each surface (Fig. 4, opposite).
Corrosion Product	Adherent dense green layer 0·005 in. thick completely covering the metal.			Green layer rather flaky in character and easily removed, some patches of the metal being bare.	Large patches (aggregating to about 30 per cent.) of the metal surface bare, and the remainder covered with a crumbly green product about 0·002 in. thick.	Upper side of specimens coated with fairly dense green product with the exception of a few patches, but underside had no continuous layer covering the metal.

TABLE II.

Condition of Wire.	Breaking Loads of Complete Wire, tons.	
	2 Per Cent. Tin-Bronze.	2 Per Cent. Cadmium-Bronze.
New	0·866	0·928
40 months' service in Haddon Tunnel	0·638, 0·637, 0·591 (Mean = 0·622)	0·582, 0·574, 0·489 (Mean = 0·548)
40 months' service in Woodside Tunnel	0·666, 0·694, 0·701 (Mean = 0·687)	0·628, 0·594, 0·585 (Mean = 0·602)

* Paper entitled "The Corrosion of Copper and Some Copper Alloys in Atmospheres Highly Polluted with Coal Smoke," presented for written discussion to the Institute of Metals. Abridged.

† See *Jl. Inst. Civ. Eng.*, vol. 16, page 65 (1941).

‡ *Loc. cit.*

CORROSION OF COPPER ALLOYS.

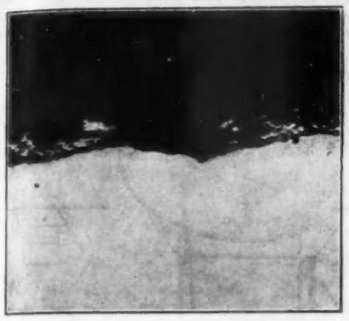

FIG. 1. SURFACE OF COPPER SHOWING RE-DEPOSITED METAL. × 250.

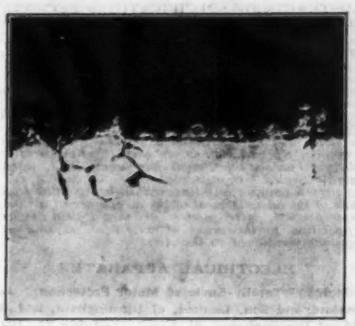

FIG. 2. SURFACE OF EVERDUR. × 250.

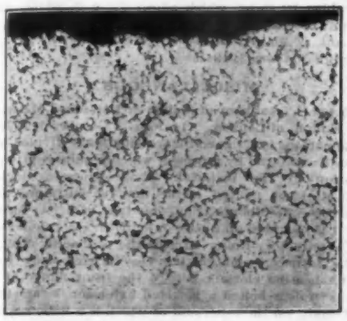

FIG. 3. CORROSION PENETRATION INTO ALUMINIUM BRONZE 2B. × 30.

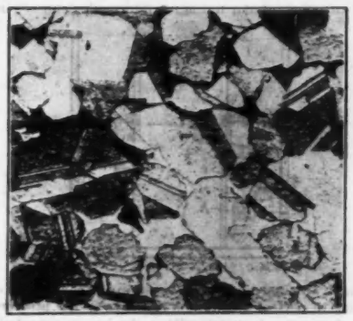

FIG. 4. STRUCTURE OF ALUMINIUM BRONZE 2B. × 250.

FIG. 5. STRUCTURE OF ALUMINIUM BRONZE 11. × 250.

FIG. 6. CORROSION PENETRATION INTO ALUMINIUM BRONZE 11. × 800.

in many respects, those found by Bengough and May on copper corroded by neutral sodium chloride solutions. There is the same large quantity of basic salt, some normal salt, and the layers of copper or of cuprite on the metal surface. Probably the continual wetness of the metal exposed in the tunnels produces the effect of complete immersion in liquid. The general action is probably an electrochemical process developed from superficial variations either inherent in the metals, as for the intercrystalline penetration observed, or due to drops of moisture or particles of soot resting on the surface. This results in the formation of normal copper chloride and sulphates at anodic points and the discharge, at first, mainly of hydrogen ions at the cathodic points, producing there some local reduction in acidity. If conditions are not too acid the mixture of anodic and cathodic products produces some basic sulphate and chloride. Chlorides of copper that escape this form of "fixation" may still be held as insoluble products by reaction with oxygen, as indicated by Bengough and May, and the production of cuprite is part of this process. The copper deposits observed on the surface of the corroded metals are no doubt due to secondary changes. Probably, as suggested by Bengough and May, in corrosion by sodium chloride solution the copper is deposited in cupric chloride concentration cells.

The slightly soluble cuprous chloride, expected as a primary corrosion product, will not be readily washed away, and much of it will be retained at the metal surface, giving the secondary changes a chance to take place there. Sulphates that escape immediate precipitation by cathodic alkali may easily be lost, for, if by hydrolysis they acquire a basic character, such a change must take place in solution and the product will not be likely to adhere to the metal. It is not surprising, on this view, that chlorides predominate in the corrosion products from the tunnels.

In the open air, the solutions come into contact with the metal only intermittently and are much less concentrated than those in tunnels. There is thus less chance of the initiation of corrosion by dissolved sulphates and chlorides. Gaseous impurities, such as hydrogen sulphide, possibly because they penetrate the primary oxide film and adhere to the metal more effectively than ions in dilute solutions, may play a more important part. This accords with the finding of Vernon and Whitby that the films initially formed on copper in the open air are a mixture of oxide and sulphide of copper with soot. Certainly, the slow rate of accumulation of sulphates and chlorides is not due to their removal in rain-water, since shelter from the rain retards the development of green deposits. Vernon and Whitby suggest that the green layers formed later on are, in some part, due to the oxidation of the first-formed sulphide deposit. Such a method of formation explains why chlorides are so inconspicuous in most of the products examined, in spite of their corrosive nature and of their widespread occurrence in rain.

In locations near the sea or exposed directly to sea-breezes, the concentration of chloride in the rain falling on to the metal may be sufficient to initiate electrochemical corrosion of the form suggested for tunnel conditions. It is noteworthy that the higher-chloride patinas examined by Vernon and Whitby are those that are believed to have been formed most rapidly, and that Hudson also noticed a more rapid formation of green deposit where exposure to chlorides was greatest.

Corrosion of Aluminium Bronze.—Of the two samples of aluminium bronze exposed in St. Pancras Tunnel, the alloy 2B with 9·1 per cent. of aluminium had a distinct $(\alpha + \beta)$ structure, but alloy 11 with 8·6 per cent. of aluminium had only a few streaks of the $(\alpha + \delta)$ eutectoid scattered through the α constituent. The difference in resistance to corrosion was remarkable. After exposure, the β constituent of the alloy 2B had been replaced by a copper residue for two-thirds of the thickness of the sheet, the α phase being unattacked, whereas during the same time the alloy 11 suffered superficial damage only (Figs. 3 to 6).

The formation of copper in the alloy 2B appears to have been due to the selective removal of aluminium, for there is no gap between copper and unchanged metal, such as might be expected if the copper resulted from a re-deposition process. The corrosion of alloy 11 was intercrystalline, possibly following traces of a second constituent. A copper residue (which can be seen in Fig. 6) has been left in the track of the attack, and appears as a general layer on the surface. This resembles the deposit formed on copper and seems more likely to be the result of re-deposition. The corrosion of aluminium bronze in acids has been investigated, in Italy, by Musatti and Dainelli, who found that, for an alloy containing 10 per cent. of aluminium, the production of a fine-grained structure considerably accelerated corrosion by hydrochloric or sulphuric acid, and that the $(\alpha + \delta)$ eutectoid could be selectively dissolved. McKay and Worthington, in the United States, reported the appearance of copper deposits at the water-line on aluminium bronzes of unspecified composition after partial immersion in acids, and the selective corrosion of two-phase alloys, both of which they describe as "de-aluminification." (The present author suggests that, if a special term be required, "coppering" is easier to say and is just as accurate a representation of the occurrence). Corrosion tests by the American Society for Testing Materials have shown that duplex alloys may be more rapidly corroded than single-phase alloys in salt water.

TABLE III.

Metal.	Copper, per cent.	Aluminium, per cent.	Iron, per cent.	Structure as Received.
Sheet 11 ..	91·0	8·6	0·3	α + discontinuous eutectoid.
,, 2B ..	90·3	9·1	0·5	α + continuous β
,, BGY	91·0	8·5	0·33	α + discontinuous eutectoid.
Bar BFB	90·6	9·3	0·05	α + continuous eutectoid.
,, BIE	93·5	6·4	0·02	α

The various reports cited above and the results obtained in the tunnel exposure, while agreeing in the general tendency that a continuous second phase favours increased rate of penetration of corrosion, appear to conflict as to the actions giving rise to copper residues. A few laboratory experiments were, therefore, made, using samples of the alloys 11 and 2B and three further aluminium bronzes. The compositions of the alloys used are shown in Table III. In addition to work on the alloys as received, samples of some of the alloys were heated to 900 deg. C. and then quenched in water, or cooled in the furnace to 700 deg. or 500 deg. C. and quenched. There was thus obtained a series of microstructures which included homogeneous α, $(\alpha + \beta)$ in continuous networks, $\alpha + (\alpha + \delta)$ eutectoid in continuous networks, α with dispersed β masses, and α with dispersed eutectoid masses.

Most of the experiments were made with sulphuric and hydrochloric acids of from 0·001 to N concentration, but some were made in neutral solution. In general the specimens were half immersed in the corroding liquid, specimens of rod being mounted vertically with the lower portion held in paraffin wax and specimens of sheet being suspended vertically. Some experiments with drops of solution were also made. The metal surfaces were ground with emery paper, finishing with Hubert 00 and a final wash in ether. The beakers containing the corroding metal were enclosed in large dèsiccator vessels, but, although vibration and evaporation were slight, there were temperature variations of about 2 deg. C. The results are summarised below.

(*a*) *Homogeneous α Structure.*—In N-hydrochloric or sulphuric acids there was general etching of the immersed surface, excepting the meniscus zone, which received a deposit of metallic copper. The zone immediately below the meniscus was very severely corroded. Both copper and aluminium were found in solution. When drops of N-sulphuric acid were left on the alloy, action similar to that at the water-line of the half-immersed metal was found to occur round the rims of the drops. In 0·01 and 0·001 N-acids and in neutral sodium chloride solutions, deposition of copper on the meniscus zone occurred in sufficient quantity to be observed in experiments of a fortnight's duration. Some green deposit formed, however, at the water-line zones. Evidently in the more dilute acids and in neutral solution, as in the electrodeposition of copper with an applied e.m.f., production of basic salt occurs at the cathodic regions.

(*α + β*) *Structure in Continuous Network.*—In N-hydrochloric acid the *β* constituent only was dissolved, the α phase being quite unaffected until detached from the metal by solution of the surrounding *β*. In N-sulphuric acid the same selective corrosion occurred, but, in the meniscus zone, a copper-coloured metallic residue was left filling the spaces vacated by the *β* constituent. In 0·01 or 0·001-N acids the *β* phase was also selectively corroded, but a coppery residue was left filling its space at all parts of the immersed surface.

(*α' + Eutectoid*) *Structure in Continuous Network.*—In all strengths of acid used the α phase was unattacked, whereas the δ phase in the eutectoid areas was converted to copper-coloured metal. The amount of copper appearing in solution was always extremely small; in some experiments, nil.

(*α + Discontinuous β*) *Structure.*—Corrosion began as for alloys with a continuous two-phase structure, but when the exposed *β* masses had been removed or "coppered," corrosion of the α phase occurred, and in acids of *N* strength copper was deposited at the meniscus zone.

(*α + Discontinuous Eutectoid*) *Structure.*—In N-acids the exposed masses of eutectoid were completely removed. In weaker acids, conversion of the δ constituent to a coppery residue took place.

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PRODUCTION OF NITRATES IN THE UNITED STATES.

NITROGEN, the principal constituent of explosives and fertilisers, is an important factor in modern warfare, and particular attention is being directed to extending facilities for its production in the United States, according to a recent report by Dr. R. R. Sayers, Director of the Bureau of Mines, to Mr. Harold L. Ickes, Secretary of the Interior. It is expected that the potential capacity will shortly reach 800,000 short tons a year, as compared with the production of 424,000 tons recorded in 1939. Three synthetic chemical nitrogen plants are now under construction and there will be a considerable increase of by-product nitrogen as a result of additions now being made to coke-oven plants. It is estimated that sufficient capacity should be available eventually to make the United States self-supporting in this respect. Until this additional capacity is reached, however, a considerable proportion of the country's requirements will have to be met by imports.

At the present time, the report states, about half of the consumption is produced synthetically from the nitrogen in the air, about one-third is imported, and the remainder is obtained as a by-product of the manufacture of coke. More than half of the imports of chemical nitrogen into the United States in recent years have been in the form of sodium nitrate from Chile, but, since imports from Europe have ceased, Chile's contribution has increased to three-fourths. Most of the balance is obtained from Canada, and consists of calcium cyanamide. The production of fixed nitrogen from the air, in 1939, was 280,000 tons, a total which it is hoped to raise to about 410,000 tons by modernising existing equipment and constructing additional plants. When the three synthetic-ammonia plants, mentioned above, are also completed, the combined capacity will be about 600,000 tons. The coke-oven by-products will add about 190,000 tons. Normally, about three-quarters of the domestic consumption is represented by fertilisers, the remainder being used in industry and in the manufacture of explosives. It is expected, however, that the proportion required for explosives will be increased in the future; and, in the event of a national emergency, it will be necessary still to rely on imported nitrogen to some extent.

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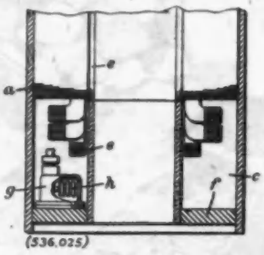
ELECTRICAL APPARATUS.

536,025. Totally-Enclosed Motor Protection. James Beresford and Son, Limited, of Birmingham, and R. L. Gold, of Birmingham. (2 *Figs.*) October 27, 1939.—The invention is a protective device for limiting rise of temperature in totally-enclosed machines. The laminated pole piece *a* and windings of the stator are enclosed within a chamber *c* formed by the casing of the motor, and an inner tubular lining *c*, and annular end covers *f*.



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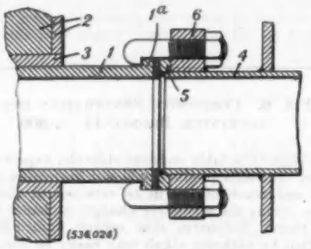
A small air-tight box *g* is arranged in the chamber *c*, consisting in part of a bellows *h* sensitive to the pressure in the chamber. A switch within the box is operated by the bellows *h* and is connected to the stator windings by a cable having a gas-tight connection to the box. The bellows operate the switch so as to open the circuit when a pressure corresponding to a predetermined temperature is reached in the chamber *c*. (*Accepted April* 30, 1941.)

FURNACE APPARATUS.

536,026. Muffle Furnace. Wild-Barfield Electric Furnaces, Limited, of Watford, and G. H. S. Grene, of Watford. (2 *Figs.*) October 27, 1939.—In large furnaces, assembly and replacement are facilitated by making the furnace parts surrounding the liner in two longitudinally separated parts. In smaller furnaces it is more usual to leave enough space to insert the flange (which is of sufficient diameter to carry the bolts) with the liner, or alternatively to weld the flange on after the liner has been inserted. The two sections of liner shown



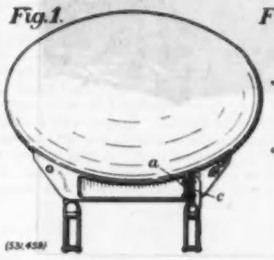
(536.024)

are a heating alloy section 1 surrounded by the fixed furnace parts 2 with an intermediate asbestos packing 3, and a thinner cooling section 4 of mild steel. An undercut flange 1*a* of the heating section is integral with it, while the cooling section has a welded-on flange 5 with a number of blocks 6 welded on behind the flange. Hook bolts passed through the blocks clamp the flanges together with an asbestos packing between them. The section 1 of the liner can thus be assembled with its flange 1*a* through the small gap occupied by the layer 3. (*Accepted April* 30, 1941.)

MOTOR VEHICLES.

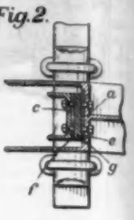
531,459. Mounting for Tanks on Vehicles. The Aluminium Plant and Vessel Company, Limited, of London, and H. F. Goodman, of London. (7 *Figs.*) July 24, 1939.—The mounting is designed to provide for the requisite amount of relative movement between the tank and the vehicle in the vertical and longitudinal directions, and to oppose transverse movement. The underside of the tank is provided with a number of fixed brackets *a* along its length, each formed with a pair of vertical jointing faces. Also, the chassis of the vehicle is provided with pairs of similar fixed brackets *c*, the jointing faces of the latter being located outside those of the brackets *a* on the tank. Between each pair of opposed jointing faces is mounted a composite element made up of two metal plates *e* and *f*

Fig.1.



(531.458)

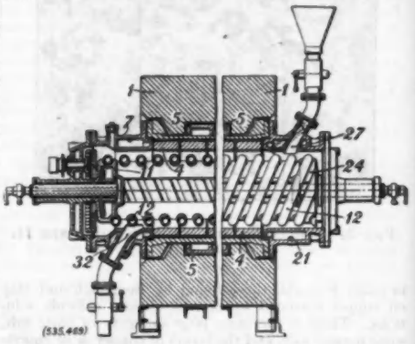
Fig.2.



(Fig. 2), separated by a pad *g* of rubber which is bonded to them. The plates are bolted one to each of the two jointing faces. With this mounting vertical and endwise movement of the tank relatively to the chassis is resisted by the rubber in shear, which allows for a relatively large amount of displacement, but sideways movement of the tank is limited to a comparatively small amount. (*Accepted January* 3, 1941.)

MISCELLANEOUS.

535,469. Treatment of Molten or Pulverised Materials. C. A. Bolton, of London. (14 *Figs.*) October 5, 1939.—The apparatus is designed for treating finely divided solid or molten material by processes which require continuous agitation of the material. These processes include purification of molten metals having entrained solid impurities, desulphurisation, mixing, *etc.* A furnace body 1 is mounted on a base or support. A tubular wall with a refractory lining 4 forms the processing chamber of the furnace, while within the furnace body is an electric heating element 5. To the front flange of the furnace wall is bolted a jacketed extension 7 carrying a short shaft, on the inner end of which is a hollow water-cooled hub 11. To the hub is integrally fitted the front end of a helix 12 to which water is supplied through the hollow shaft. To the rear flange of the chamber wall is secured a jacketed body extension 21 similar to the front extension 7. The rear end of the helix 12 is integrally fitted to a hub 24 similarly to the arrangement at its front end. The ends of the helix are welded in helical grooves in the respective hubs 11, 24. The rear body extension 21 has an inlet port 27 for the helix chamber through which the material to be treated is fed from a hopper. A semi-rotary seal is provided in the feed



(535.469)

conduit between the hopper and the inlet port 27 in order to prevent ingress of atmospheric air to the helix chamber. The extension 21 is also fitted with a water atomiser adjacent to the inlet port for use when the process necessitates a steam-gas atmosphere within the helix chamber. The front extension 7 has an outlet port 32 fitted with a semi-rotary seal similar to the inlet seal. The helix 12 is tubular so as to provide a passage for cooling, heating or processing gases or fluids. The latter are diffused into the processing chamber, or the substance under treatment, through a number of jet openings in the walls of the helix coils. A single or two-start helix may require to be supported on a spider, but if the helix consists of two coils of unequal diameter, the inner coil can be of greater pitch than the outer, and the arrangement is thus self-supporting. Where the process requires long periods of treatment for each batch in the chamber, the feed is cut off and the helix rotation is continually reversed. Another form of apparatus has an open trough type of processing chamber for processes where exposure to air is not detrimental. The specification also gives dimensions for certain examples of the apparatus. (*Accepted April* 10, 1941.)